Topic: Architectural Design or Construction Systems and Methods (Materials, Connections, Carpentry, Modulation) or Life Cycle

Form and tectonicity of the works of Simón Vélez

Arq. Carolina Salazar Ocampo
csalazaro@unal.edu.co

Associate Professor
Universidad Nacional de Colombia - Sede Manizales
Facultad de Ingeniería y Arquitectura
Escuela de Arquitectura y Urbanismo

Summary

The document presented is an advance of the research on the work of the Colombian architect Simón Vélez built in the department of Caldas (Colombia). Structures built before the year 1999 when the prototype of the ZERI pavilion was built in the city of Manizales are compared. The analysis is made from the tectonics of the structure and the form understood as an ordering concept, in an architecture in which wood and bamboo predominate as structural materials. Three aspects are studied of the selected works: structure geometry, joints and protection by design; in order to observe what characteristics are common to them, and in which aspects differences are presented.

Figure 1

Introduction

This article corresponds to an advance of the research on the "Transformation of the work of the architect Simón Vélez analyzed from the constructive point of view. Caldas - Colombia 1979-1999". The research focuses on the analysis of the architecture - structure relationship in Vélez 's work. It is not usual to find research documents in which architecture is analyzed from a technological (qualitative) and of the constructive details point of view; most texts focus on formal, spatial and aesthetic qualities, or specialize in structural calculations, focusing on more specific aspects of the engineering field. Vélez's works are built with traditional materials such as wood and bamboo (*Guadua angustifolia*) combining them with steel and concrete to enhance their structural properties. These natural materials are the living legacy of the traditional architecture of the coffee zone in Colombia and the architect from the beginning of his career has experimented with them, adapting new technologies that have allowed him to maintain the tradition.

This article presents an analysis of some of the works made by Vélez in his beginnings when he worked with wood, at the time he incorporated bamboo (*Guadua angustifolia*) and started experimenting with the joints for this material.

Points about concepts

The analysis of the relationship between architecture and structure is made taking into account the concepts of form, tectonics and tectonicity, for which it is necessary to point out these terms and in what sense they have been taken for this specific case.

Form

In the investigation carried out by Hermida (2011, 11) on one of the works of the architect Mies van der Rohe, the two meanings that the term "form" can have when talking about architecture are explained. One is that of the form taken simply as the aspect of an object with its visual characteristics, where reference is made to the German term *Gestalt*, this being a synonym of figure: sensitive or perceptible dimensions of the object. The other comes from the Greek term *eidos*, in which the form appears as the essential internal constitution of an object, that is, the arrangement and order of the parts, meaning associated with structure. In the same way that Hermida assumes the term, it is taken for this investigation: "the form understood as a structure and as a manifestation of order."

Tectonics and tectonicity

The term tectonics has been approached by several authors such as Gottfried Semper, Kenneth Frampton and Alberto Campo Baeza. The latter (2009, 31) refers to the previous two and defines in his words the term: "*tectonic* architecture is understood as that in which the force of gravity is transmitted in a syncopated manner, in a structural system with knots, with joints, and where the construction is articulated. It is the bony, woody, light architecture. The one that stands on the ground as if rising on tiptoe. It is the architecture that defends itself from light, that has to keep watching its gaps in order to control the light that floods it. It's the architecture of the shell. That of the abacus. It is, to summarize, the architecture of the cabin." Campo Baeza reaffirms the value of the structure not only as a transmitter of loads, but also as defining and ordering architectural spaces, and in the specific case of tectonics the importance of the joints that articulate the whole.

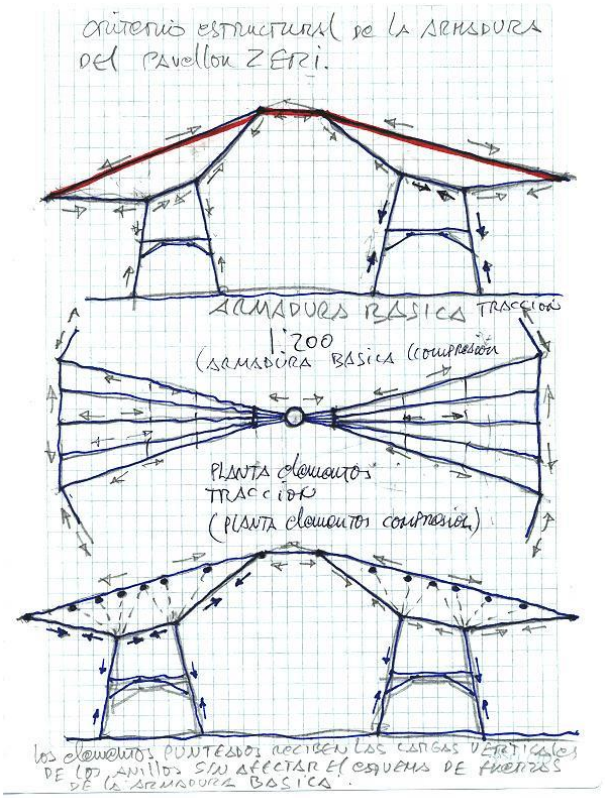

Figure 2

Going to the term tectonicity, this is the definition of Helio Piñón (2007, 101): it is "a condition of the architectural form that brings an order to the material - prior to architecture - of which architecture is nurtured." In other words it is that constructive logic that is evident in a work when the designer conceived the idea as a structural and architectural unit, in which the constructive aspect defines and orders the form.

Form and tectonics of the works of Simón Vélez

To understand the work of Vélez within the tectonic line, reference is made to the description made by Frampton (1999, 155) of the work of Auguste Perret, an architect who began his work at the beginning of the 20th century. Despite not being from the same time of Vélez and of working a different structural system, conceptually it has similarities. "We can say that the particular tectonic line of Perret's work develops the following attributes in a consistent manner: (1) the expression of the structural skeleton as an indispensable ordering principle; (2) an emphasis on the joint as a techno-poetic fulcrum[a] ; (3) the reinterpretation of traditional elements, in such a way that they could express a certain cultural continuity; (4) the resulting emphasis of certain key components such as the cornice, the French window and the spiral staircase, considered as an apotheosis of the tectonic civilization; (5) and adherence to the rational as a transferable method, dedicated to the continuation and development of a normative culture.

Regarding the first aspect, it is observed that Vélez's designs have always been governed by a mesh in which structural elements, in addition to being protagonists for their formal expression, mark the pattern for the ordering of spaces.

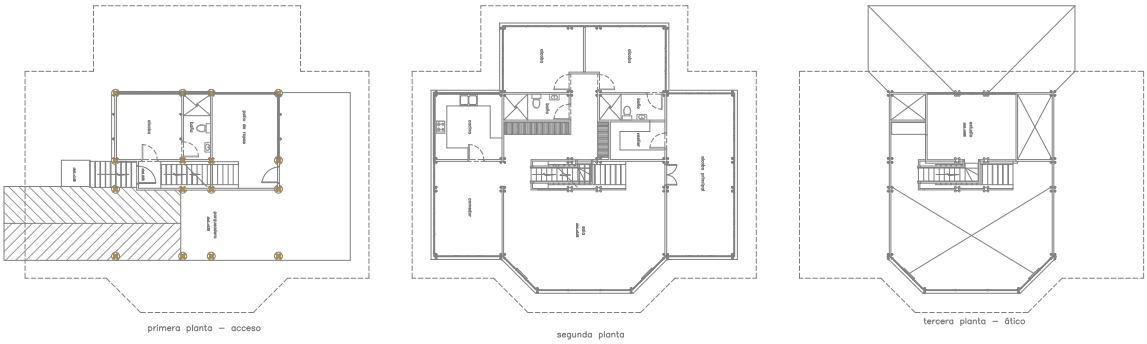

Figure 3

Continuing with the second aspect, the knot as an essential and symbolic element of tectonics, there is a constant interest in the development of the joints, understanding it as the key point of transmission of the loads to make efficient structures; in a first stage with the use of wood, and later developing techniques that offer better constructive possibilities with bamboo (Figure 4). The fact of thinking of it as a structural technical fact, does not contradict the aesthetic intention, on the contrary they complement each other.

Turning to the reinterpretation of traditional culture, a paragraph by Ramírez is cited (1991, 8), where he synthesizes this third aspect: "Construction and expression, form and meaning as one and the same thing, are the materialization of a constant search, which reject both fashion, as "what is false" and "what is apparent", returning to the essential and own. Vélez injects new meanings to the basic formulations of the regional constructive culture, renouncing to revitalize previous forms, approaching tradition in an original way. His synthesis operates at an intense level, without seeking to fuse traditions with universal compositional and distributive forms. What he has sought is to enhance, from the construction, a condensation of the place and the dwelling, of construction and landscape."

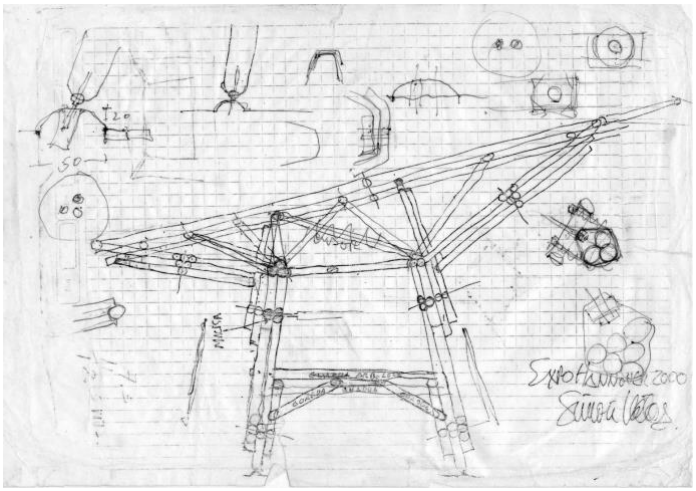

Figure 4

The fourth aspect deals with specific elements of Perret's work, which in the case of Vélez could be considered as the two keys to protection by design: the connection between the soil and the structure that (Figures 5, 6, 7), in addition to protecting natural materials, marks a symbolic transition, and the overhangs on the roofs (Figures 8, 9, 10) that have been increasing their dimensions with the possibilities given by bamboo with anchored bolts, with the intention also to protect natural elements from the rain.

Figure 5 Figure 6 Figure 7

Turning to the last aspect, it is clear that the continuous research of the architect has led him to propose technical solutions for the constructive system with bamboo *(Guadua angustifolia*), which were inputs for the creation of Colombian regulations regarding the joints of structures with bamboo (ICONTEC 2006).

Figure 8 Figure 9 Figure 10

From the mentioned tectonic attributes, 3 points are abstracted for the comparative analysis of five works[b]: the geometry of the structure referred to the point (1) the expression of the structural skeleton as an ordering principle, the joints in general referred to the point (2) and the point (4) specifically for protection by design. All these observing the coincidences or differences according to the materials used.

Geometry of the structure

In the works of Vélez, spatial order is generated by the layout of the structure, which is modulated taking into account the possibilities offered by the materials used. In his sketches the structural coherence is appreciated where there is a clear relation between the elements observed in the floorplan and cross section. This aspect is evidence of the inspiration that Vélez had from traditional Japanese architecture with its system of proportions, described by Favaro (2012, 26): "An important achievement of Japanese architecture is the use of a modular system based on the interval between the columns. From this original proportion, all other proportional relationships between structural elements were determined beams and other supporting elements of the structure. The size of the elements is not based solely on structural requirements, or on a rigid idea of order. It is based mainly on aesthetic considerations."

In both cases the modular system is evident, however the pattern in the design of Vélez, does not arise from the columns as in Japanese architecture, but on the contrary, it is the structure of the roof that generates the organization of the other elements that, when they reach the ground, maintain a rhythm with constant intervals.

This principle has been maintained from its beginnings to the current works, as well as the definition of simple architectural floorplans with orthogonal or of regular geometric figures disposition, worrying more about the detail of the tectonic elements that make up the structure. This aspect is recognized by himself, expressing that he feels more like an engineer for designing very simple floorplans without much deployment of architecture (Vitra Design Museum 2000, 62). This is also how Ramírez expresses it (1991, 6) referring to the first works made by Vélez in the 1970s: "In a first stage of his work, he explores the possibilities of structures centered on triangular vertical supports, which determines the layout of the interior floorplans. Although the floorplans are very simple, the cross section is complex, making the construction space more dynamic. In this way, these constructions resemble large habitable trusses, raised over the ground... In these works prevails the aerial sense of the structure and the great dynamics of the space, developing more and more a spectacular sense of the structure. It is necessary to emphasize the elementary sense of the disposition of the floorplan and the disinterestedness for "composing" the facade, displacing all the protagonism to the cross section".

Floorplans

In addition to the simple and rational way in which he treats the floorplans, it is evident that all the cases analyzed have a symmetrical composition, which some authors have compared with the Palladian villas.

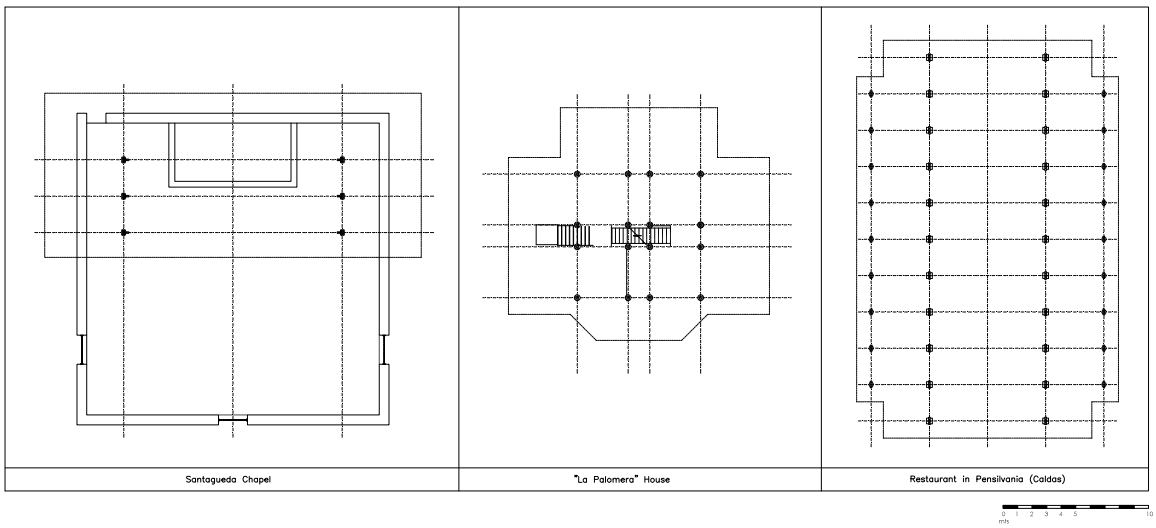

Figure 11

Ramírez (1991, 7) speaking about the works made in the 1970s and referring to a quote by Galaor Carbonell states: "Already at that time he has assumed a symmetrical arrangement, of classical compositional type, which refers to the Palladian villas. Galaor Carbonell draws attention to the way he "uses symmetry as a way of relieving the structure and the functional zoning of the construction, projecting it as a seated and diaphanous image, whose conceptual clarity prevails over the transitory, temporary and circumstantial nature of the materials and some concepts of popular architecture, through the majesty implicit in the principle of symmetry."

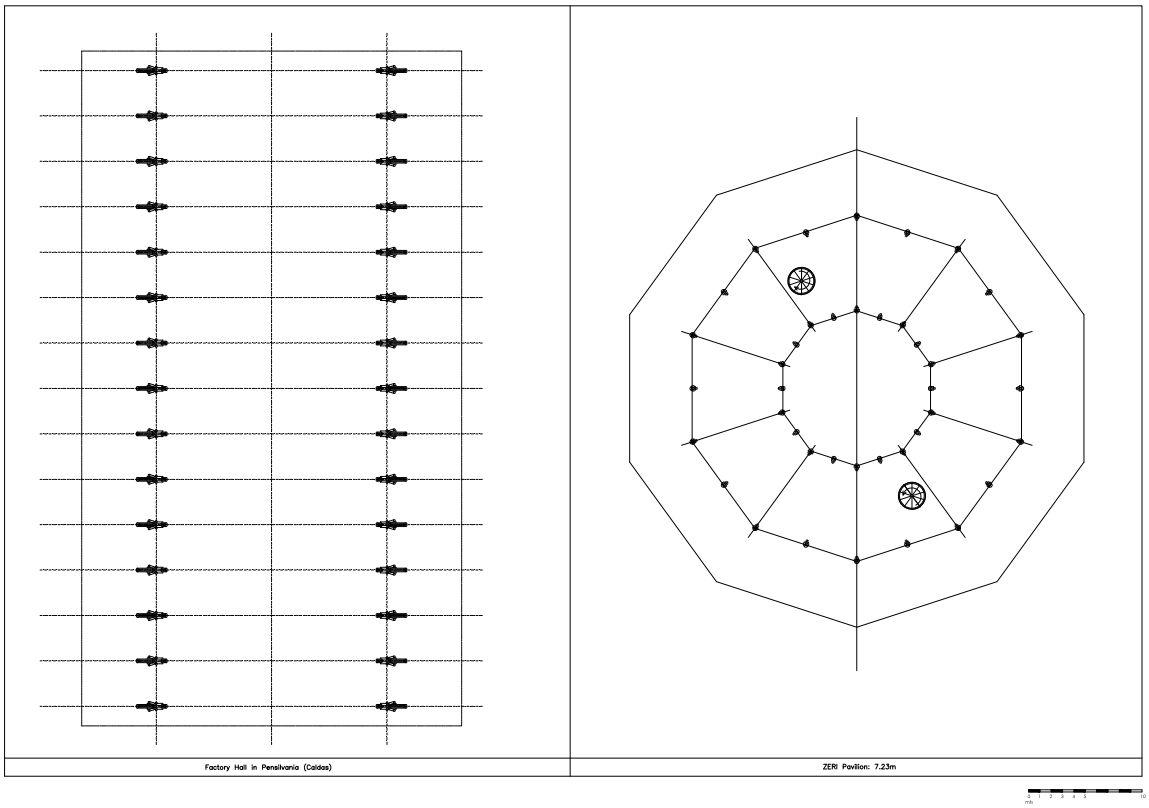

Figure 12

It is also clear that for those who design structures, symmetry is the ideal principle for the stability of the work, since there is a balanced distribution of the loads towards the ground. The architect when interrogated (Vitra Design Museum 2000, 61)on the subject of symmetry and the comparison that has

been made with the Palladian villas, he states: “When you look at traditional architecture, you see that it is always an attempt to be symmetrical. If you put a pencil and paper in the hand of a child and ask him or her to draw a house, the child will draw something symmetrical. Curiosly enough, asymmetrical architecture is described as organic architecture although everything in nature strives to be symmetrical.”

Cross sections

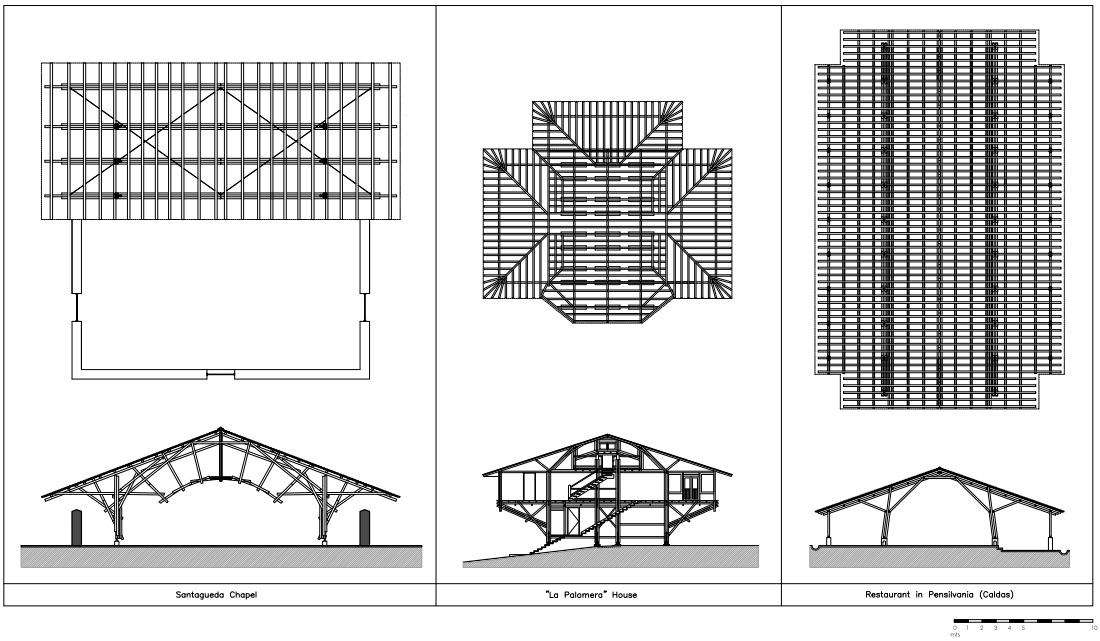

Figure 13

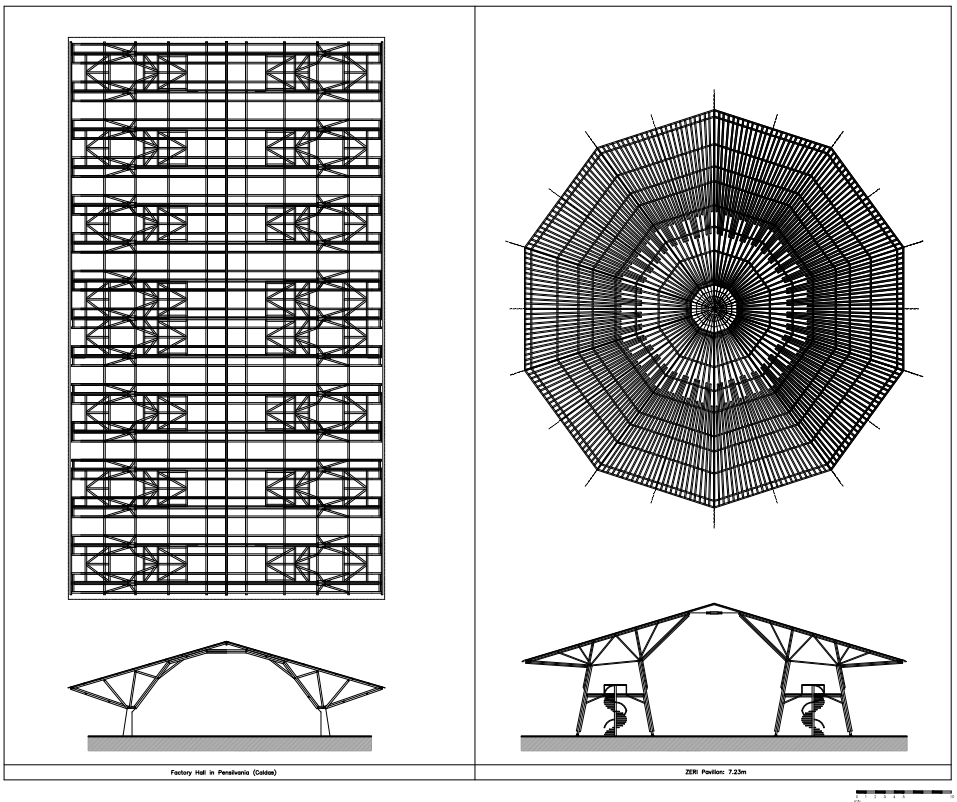

Figure 14

From that simple order that is perceived in the floorplans, a display of elements is generated that at first sight are difficult to understand, but when analyzing them they also reflect a geometric order that responds to the efficient transmission of the loads to the ground. Ramirez (1991, 10) refers to this topic, citing observations made by Daniell Barbaro in his Treaty on Architecture, about the vitrubian trilogy - *firmitas, utilitas, venustas* -: "To the floorplan would correspond order and kindness, to the cross section, beauty, character and meaning. In this sense, the attention of Vélez on the cross section, translates more the intention of his work focused on the structural aspects, the tectonics of the work itself."

Joints

In the 1970s, when common architects explored materials such as concrete, steel and masonry, architects such as Simón Vélez appeared, focusing their interest on retaking traditional materials such as wood and later on bamboo. These natural materials together with canes, were those used to raise *tectonics* architecture before the use of steel. To build with these elements it is necessary to define an assembly system, or procedure as Semper explains (Frampton 1999, 16): "tectonics of the structure, where the light linear components are assembled as if they covered a spatial matrix."


Figure 15


Figure 16


Figure 17

Bolted joints have been the common denominator in the structures designed by Vélez. In the beginning, using woods such as round mangroves *(Rhizophora mangle* [c]) and pine *(Pinus patula*[d]*)* or sawn *sapán (Clathrotropis brachypetala* [e]), and later incorporating bamboo and other natural materials[f]. According to Semper (Frampton 1999, 91)"The most significant basic tectonic element was the joint or knot."


Figure 18


Figure 19


Figure 20

Vélez from the method of trial and error, came to develop the technique of unions described in Grow your own house (2000, 110): "Inspired by traditional usages, Simón Vélez has developed a technique bringing to mind the joints in high-tech buildings. Since bamboo has an enormous tensile strength, Vélez developed a system especially for constructions subject to tensile vectors. First, the end sections of the bamboo canes to be bound are filled with concrete; into the concrete he inserts metal elements parallel to the run of the cane. The parts can then be connected using the metal links. Consequently, a high proportion of the force to which the cane is subject at the end is transferred to

the sturdy dividing walls of the canes, and the splintering which normally occurs in hollow canes is avoided".

This experimentation with materials and techniques is definitive, in the sense of understanding the properties of each material and its behavior according to the way they are ordered and articulated. Salvadori (1980, 25) speaks in this sense, when he tries to explain that in the morphological conception of a structure, specialized theoretical knowledge is not necessary, but simply intuition about the structural principles: "A structure is an artifact expressing one of the many aspects of human creativity, but it is an artifact that can not be created without a deep respect for the laws of nature". Later, in reference to the experience, he says (1980, 44): "Structural design, the determination of the shape and dimensions of structural elements, can only be learned by experience".

Protection by design

One aspect that is reflected in all of Vélez's works is protection by design. The architect recognizes that there are procedures to protect materials from climate and pests, but he emphasizes that the proper design of the roof and the bases are the best defense against the humidity of bamboo and wood[g].

Bases

The formal expression of the bases varies between one work and another, but the materials and techniques are usually the same. The fact that each work formally explores this system denotes the symbolic value of the emergence of the structure. Frampton (1999, 92) refers to this aspect: "Semper's emphasis on the act of joining implies a fundamental syntactic transition that is expressed as we move from the stereotomic base of a building to its tectonic structure, a transition that is the true essence of architecture."

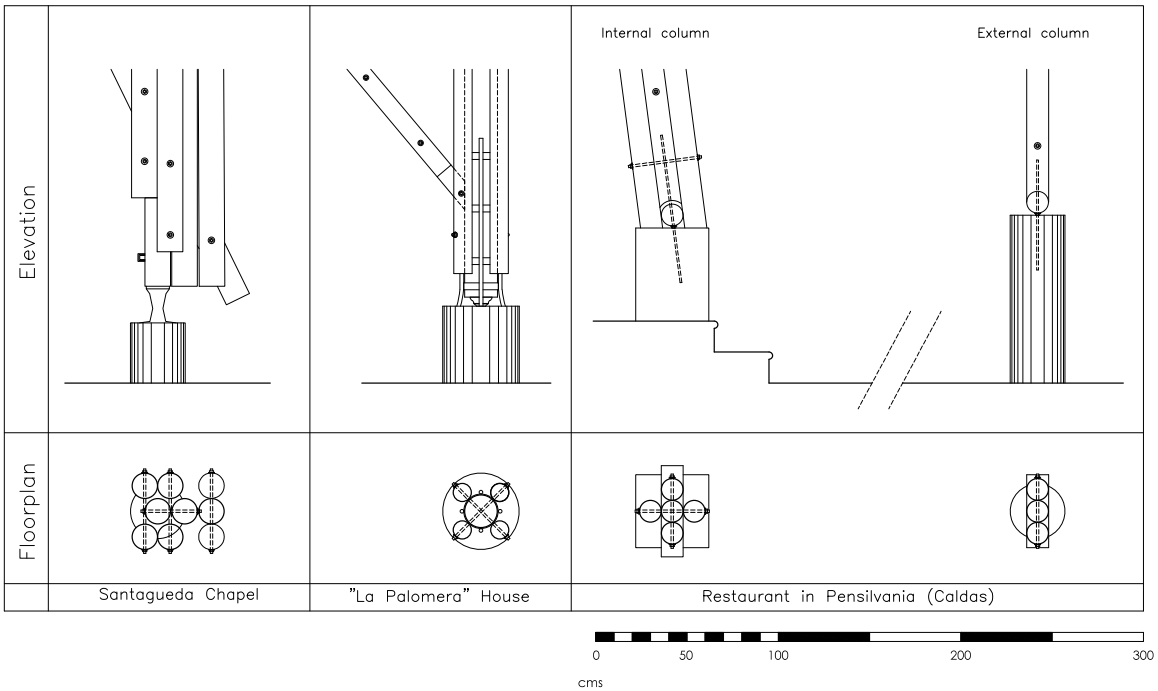

Figure 21

Turning to the technical aspect, there is a transition between the reinforced concrete foundation and the wood or bamboo structure, where a steel bar appears that transmits the loads and articulates both materials. This connection is protected and sometimes reinforced with cast iron washers specially designed for each case. The wooden or bamboo elements that arise from the base and support the

weight, form the columns grouped with more elements (bamboo sticks or wooden trunks), which transfer loads and stabilize against lateral breaks. Throughout this set of elements appear connecting screws and when necessary clamps that ensure the union.

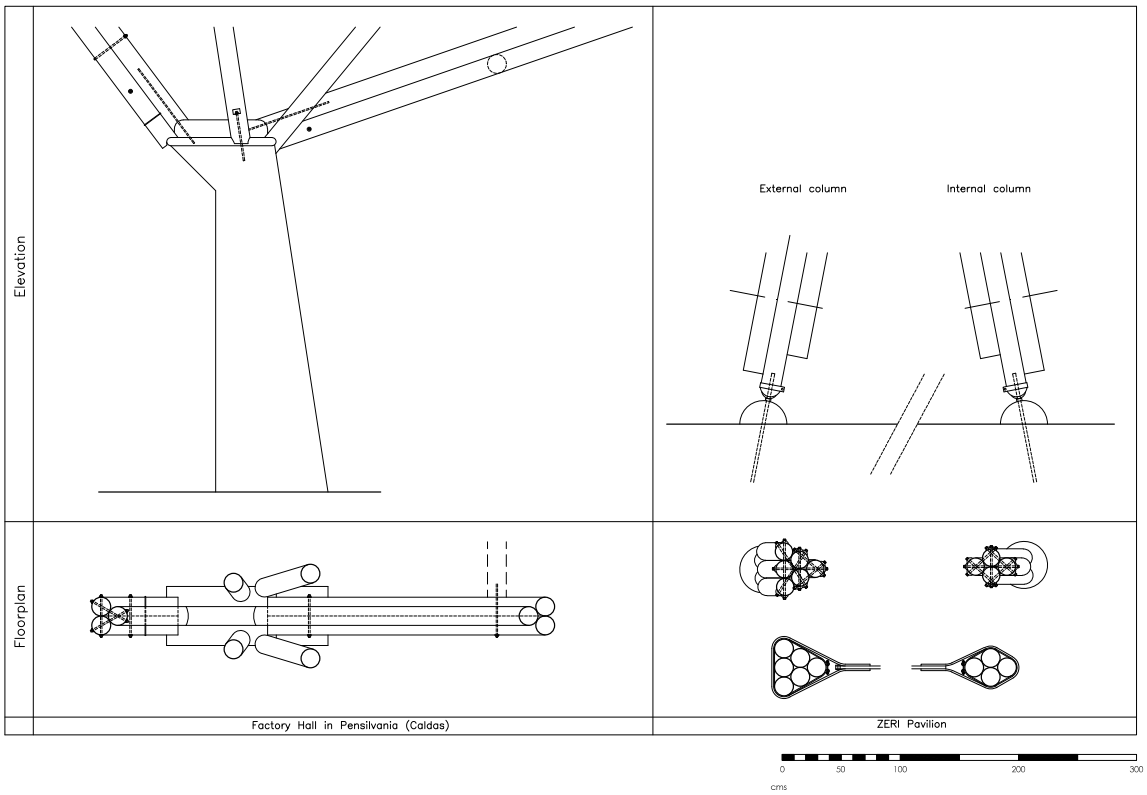

Figure 22

Roof - Cantilever

The roof as the protective system of the structure is the protagonist in the works of Vélez. He considers himself a "roof architect"[h], and as mentioned above the conception of his designs is developed from above. Also in some works, the constructive process of the structure begins with the roof, as is the case of the ZERI Pavilion[i]. From the first works built with wood, the intention is to extend the roofs as far as the material allows, but it is finally the bamboo (*Guadua angustifolia*), which allows to expand the possibilities of creating cantilevers of greater dimensions with the development of the technique of bolted joints[j].

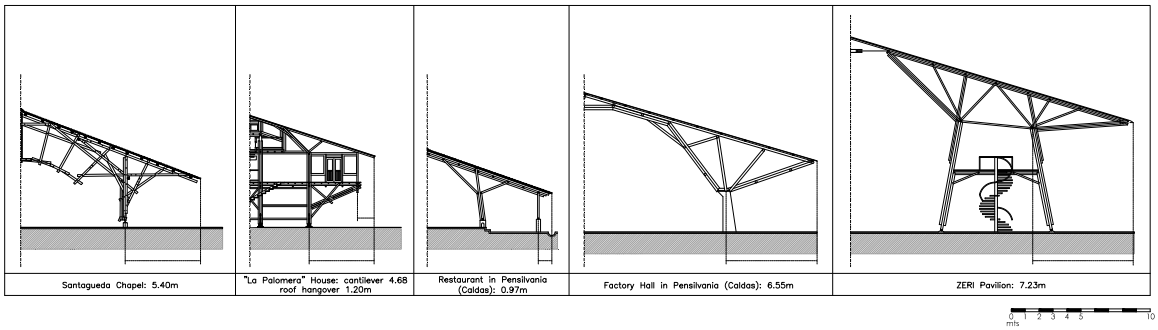

Figure 23

Conclusions

One of the characteristics evidenced in the analyzed works is the indivisible relationship that exists between architecture and structure, and the development of the joints that respond to the knowledge of the materials used in his works. The fact of having experimented with these materials for many

years and understanding their physical properties, has given the possibility of developing efficient structural approaches. This aspect that is recognized in the work of Vélez, is not common in architectural design at present, where the structural proposal comes later, in some cases without having a formal and spatial coherence, and in others being hidden within architectural covers, because it simply fulfills the function of supporting loads and preventing the building from collapsing.

Formal expression of the structure has a constant that is the strict modulation of all the elements that compose it, with simple geometric compositions applying the concept of symmetry. The ordering principle of the works is established by the structure. The differences lie in the formal expression of details such as the bases and types of joints, which give specific visual characteristics to each of the works.

Although the technique of joints for the bamboo has allowed to make more daring structures and with better results, roof overhangs up to 6.55 meters are observed in some works constructed with wood.

The structures analyzed are between 20 and 30 years old and despite the fact that in some cases the elements that compose them have some deterioration, they are still standing. It is considered that one of the aspects that have a greater impact on their conservation, is protection by design.

Bibliographical index

Campo Baeza, Alberto, 2009. Pensar con las manos. Nobuko, Argentina. 228 pp.
Favaro, Franco, 2012. Myron Goldsmith: la expresión formal de la estructura: The Republic Newspaper Plant & Offices, Columbus, Indiana (Proyecto final Maestría). Universidad Politécnica de Cataluña UPC, Barcelona. pp. 26.
Frampton, Kenneth, 1999. Estudios sobre cultura tectónica, Poéticas de la construcción en la arquitectura de los siglos XIX y XX. Ediciones Akal, S.A., Madrid. 383 pp.
Hermida, María Augusta, 2011. El detalle como intensificación de la forma El Illinois Institute of Technology de Mies van der Rohe. Universitat Politècnica de Catalunya. Departament de Projectes Arquitectònics. pp. 11.
ICONTEC, 2006. Norma Técnica Colombiana NTC-5407 Uniones de estructuras con guadua angustifolia kunth.
Piñón, Helio, 2007. La forma y la mirada. Nobuko, Argentina. 162 pp.
Ramírez Potes, Francisco, 1991. Notas sobre la arquitectura de Simón Vélez. Arquitectura 11, pp. 3–10.
Salvadori, Mario, 1980. Why buildings stand up: the strength of architecture. W.W. Norton & Company, Inc., New York. 323 pp.
Vitra Design Museum, 2000. Grow your own house. Weil am Rhein, Alemania. 255 pp.

---

[a] Fulcrum: (s) formal: the main thing or person needed to support something or to make it work or happen. https://dictionary.cambridge.org/es/diccionario/ingles/fulcrum

[b] Santagueda Chapel (1982-1986) and “La Palomera” House (1984): made of mangrove. Restaurant in Pensilvania, Caldas (1993): made of *guadua*. Factory Hall in Pensilvania, Caldas (1993): made of pine. Prototype of the ZERI Pavilion (1999): made of *guadua*, *aliso*, *arboloco* and *chusque*.

[c] mangle. (*Rhizophora mangle*) en Bernal, R., G. Galeano, A. Rodríguez, H. Sarmiento and M. Gutiérrez. 2012. Nombres Comunes de las Plantas de Colombia. www.biovirtual.unal.edu.co/nombrescomunes/nombrescomunes/detalle/ncientifico/29035/

[d] pino pátula. (*Pinus patula*) en Bernal, R., G. Galeano, A. Rodríguez, H. Sarmiento y M. Gutiérrez. 2012. Nombres Comunes de las Plantas de Colombia. www.biovirtual.unal.edu.co/nombrescomunes/nombrescomunes/detalle/ncientifico/26508/

[e] sapán. (*Clathrotropis brachypetala*) en Bernal, R., G. Galeano, A. Rodríguez, H. Sarmiento and M. Gutiérrez. 2012. Nombres Comunes de las Plantas de Colombia. www.biovirtual.unal.edu.co/nombrescomunes/nombrescomunes/detalle/ncientifico/13661/

[f] In the ZERI Pavilion he combined with bamboo (*Guadua angustifolia*) other tropical plants such as: aliso (*Alnus acuminata*), arboloco (*Montanoa quadrangularis*) and chusque (*Chusquea serrulata*).

[g] Simon's answer to Mateo Kries's question about the life expectancy of bamboo: "There are bamboo houses in Manizales that are 100 years old. The only thing that remains of them is the bamboo. In Japan, too, there is an abundance of knowledge on how to treat bamboo against weather and pests. The best protection, however, is a good design. Overhangs can be used to make sure the poles don't get damp, with concrete bases supplying the protection from underneath". (Vitra Design Museum 2000, 64).

[h] When questioned about the architectonic style that describes him, the architect responds: (Vitra Design Museum 2000, 59)"I would define myself as a «roof architect»." I design the roof first an then what comes beneath it. Roofs have to withstand weather and always reflect the culture they come from. Unfortunatelly, thanks to the success of modern architecture and the flat roof, the gable roof has become a symbol of folk architecture… My architecture is tropical architecture. In a country where it rains a lot, you have to build roofs wiht large overhangs like in Chinese or Indonesian architecture."

[i] In the construction of the ZERI pavilion, after having progressed with the foundation process, scaffolds are installed, on which are built the rings from which the roof is raised. Subsequently the columns are raised and articulated with the bases and rings (beams that form the ten sides polygon).

[j] In this part of the interview the architect explains the behavior of the bamboo joints for the construction of cantilevers (Vitra Design Museum 2000, 62): "There is, for example, a fundamental principle which enables me to build the large overhangs for such heavy roofs. I have discovered how bamboo can withstand tensile pressure if connected by tensile joints. I experimented with filling the last chambers of the bamboo can with concrete and set metal elements into the concrete. The poles could thus be joined with these elements with the tensión then distributed through to the chamber walls of the cane."

List of figures

Figure 16: Joint detail of “La Palomera” House. Photo: Carolina Salazar
Figure 17: Joint detail of Restaurant. Photo: Carolina Salazar
Figure 18: Joint detail of Factory Hall. Photo: Carolina Salazar
Figure 19: Joint detail of ZERI pavilion. Photo: ZERI©
Figure 20: Joint detail of ZERI pavilion. Photo: ZERI©
Figure 21: Comparison of bases of the analyzed cases: Santágueda Chapel, “La Palomera” House and Restaurant. Drawings: Carolina Salazar. The schemes of the chapel are based on drawings drawn by Jhon Eduard Gonzalez M.
Figure 22: Comparison of bases of the analyzed cases: Factory Hall and ZERI Pavilion. Drawings: Carolina Salazar
Figure 23: Comparison of cantilevers of the analyzed cases. Santágueda Chapel, “La Palomera” House, Restaurant, Factory Hall and ZERI Pavilion Drawings: Carolina Salazar. The schemes of the chapel are based on drawings drawn by Jhon Eduard Gonzalez M.