Constructive Sincerity and Bioclimatic Architecture

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Abstract The materiality of architecture is an inescapable issue when it comes to building, however, throughout history there have been few examples that focus on its expressive possibilities. Materials can be seen as the 'pixels' of architecture, and are what allow us to create spaces, geometries and textures, but at the same time they are also elements with mechanical and physical characteristics that generate structural systems and thermal comfort in interiors. In addition, the environmental implications of the costs of extraction, transformation, end use and disposal are enormous, since the wrong choices can saturate the planet and, in some cases, affect health. Industrial modernity has produced a huge number of new materials from the oil and chemical industries, relegating traditional—and much more sustainable—materials to the background. The study of ancestral vernacular systems allows us to appreciate the development of techniques through trial and error that allow buildings to adapt and interact with their environment. The teachings contained in the examples that still survive allow the modern designer to be inspired towards a more sustainable approach, and can also generate modern interpretations. This has increased with the contemporary development of new systems and materials within the field of bioconstruction, a field that, though still in its infancy, has already resulted in some innovations of great interest. Integrating sustainable materials in modern projects is an exercise in responsibility, which offers the opportunity to investigate its sensory possibilities through its exposed and solid use, without coatings. Therefore, working with constructive clarity and using bioclimatic materials allows the building to connect with memory, the context and respect for the environment, as well as generating evocative atmospheres full of meaning.

Keywords Material · Bio-construction · Architecture · Sustainability

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J. E. Torres-Quezada (ed.), *Energetic Characterization of Building Evolution*,
Green Energy and Technology, https://doi.org/10.1007/978-3-031-21598-8_4

1 Introduction

Although bioclimatic architecture has been developed since the dawn of time, in recent decades it has been conceptually interpreted through what is generally called sustainable architecture. While the former is based on more natural resources, the latter has much more materialistic and capital-related connotations, although it is promoted through an idea of survival. Bioclimatic architecture has cultural, traditional and local connotations, while sustainable architecture paradigms are, in most cases, global in nature. The emerging need to save energy and conserve the environment, not as a moral commitment but as a necessity, has led to modern models being established on the basis of measurable and scientific parameters. Energy certifications, embodied energy assessments or green building seals are along these lines. This makes it possible to determine energetically, environmentally and economically the strategies and results they produce, but the aspects of utmost relevance that underlie ancestral architectures are left aside.

This marked global character of everything that is developed in the modern world, which has in its principles replicability, mass production and economic performance, makes the proposals that arise become inextricably linked to the chemical and petroleum industries, using in a large number of cases the waste they generate to produce building materials. An example in this direction is the Passivehaus standard, which prioritizes energy savings over other concepts such as the life cycle assessment, the health of materials and the ingenuity of bioclimatic architecture. This method that prioritizes the insulation systems-based approach for energy saving, has its complement with another product of globalization: the use of machines. The applicability and replicability of these systems generate effective solutions from their perspective, but produce disconnections with the vernacular and with human health. Although such systems are not at odds with the possibility of being included within the framework of the vernacular through good architecture, they certainly do not favor a design process that connects with memories, transcendence and the most essential principles of architecture.

The general normative perspective places serious difficulties on designers who try to meet its parameters and at the same time generate an architecture within the bioclimatic and vernacular framework. There is also a gap between the sustainable and the conceptual within architecture, which encourages proposals that are disconnected from the place, history and culture. This situation affects the design of the building itself and, to a large extent, the choice of materials and their construction systems.

Obviously, if the industry put its efforts into the development of much more ecological and local building materials and systems, amazing results would be obtained, both in their technical performance and in their economic and environmental balance. There are already insulations based on cork, hemp fibers or sawdust from lumberyards. There is also an incipient development (or rather recovery) of lime technology, raw earth and silicate paints, to give just a few examples. All these materials not only have a lower impact on the environment and on health, but also improve the properties

of conventionally modern ones. However, their low production and demand mean that they are not competitive against chemical derivatives, cement, steel or zinc.

The trend of bioconstruction within architecture can be seen as a vindication of these ancestral and natural materials, but it must have a normative support that sustains it. It is not even necessary for these materials to prevail over others, since it is would be enough if there were legislation that allows them to be used as a structure or as an envelope, through the characterization of their physical and chemical properties.

As an example, in the world there are several countries that have regulations regarding the use of raw land as a building material. However, most deal only partially with the different existing construction systems, generally focusing only on one or two techniques. For example, in Spain, France and Colombia only the compressed earth block (CEO) system is permitted for walls, partitions and facades; in Brazil and India, the CEO and Tapial; while the USA and New Zealand are among those whose regulations include rammed earth, adobe and CEO [1]. Ecuador does not have any regulations in this regard, and there are few countries in the region that regulate these systems. In addition to this lack of regulations at a global level, in many cases the raw earth system is justified through the inclusion of cement in its composition, which detracts from the result from a bioconstruction perspective.

The issue of materiality is the great challenge of modern sustainable architecture, being inextricably linked to the local development of materials and construction systems, an idea which is diametrically opposed to the global paradigms of standardization and simplification.

Therefore, an opportunity arises to involve sustainable materiality within the scope of architecture, thus generating proposals that allow a leading role for the material beyond its purely practical application. The most forceful ways of working with material in architecture always obey a solid use of it, that is, without coatings or intermediate layers, according to two of Banham's three principles in his definition of New Brutalism: the use of materials in their inherent form; and the evident display of the structural system [2]. This has been applied throughout history in many cases, but it was with the modern movement when reflections on the material and its place in the project became more relevant, especially thanks to Le Corbusier and his great discovery: brutalism.

The methodology of this chapter is based on a critical review of the issue of materiality, establishing two very different points of view. On the one hand, the constructive sincerity and the phenomenology associated with it, developed through history and presented in a more literal way in some cases of the modern movement. On the other hand, materiality from a bioclimatic perspective, which is much more pragmatic, based on the resources available in the environment, and on the search for comfort conditions. It is based on the hypothesis that both approaches can be included in a project, though they have different origins, and can create a way of creating architecture that allows the results to be in line with both the pragmatic and the conceptual, and always with the focus of materiality.

The objective of this chapter is to carry out a critical reflection on the relationship between the most conceptual parts of architecture and the principles of bioclimatic

architecture, through the perspective of materiality, extrapolating the conclusions to the Ecuadorian case.

2 The Material in Architecture

> The achievements of war engineering in concrete, steel and wood have given signs of sufficient maturity to guide the conception of these new buildings. The gigantic structural skeleton has established its right to be seen. You no longer need any disguise to please. New envelopes made of transparent, translucent or opaque materials, with exciting textures and colors, can be suspended from their members. Painted friezes will articulate the circulations between the large enclosures and sculptures will embellish their interior.

Louis Kahn: Essential Texts. Edited by Robert Twombly: 2003. W. W. Norton and company. New York–London.

The history of construction technologies is linked to the history of materials. In architecture, both are presented at the same time, the material never being prior to the technique, since the latter configures the former. Although the stone existed before the building, it does not become a construction material until it is tamed through a construction technique. As an example of proto-architecture, the dolmen is configured through a lintel concept, which requires stones with a certain geometry. The stones go from being rocks that rest on a mountain to becoming a structure that is stressed through compression and flexo-traction. But this is actually secondary, because the primary goal of its builders was to create a space related to an environment and the cosmos. The complex and holistic relationships that exist in architecture are similar to those in sculpture. Space and form are materialized by stone, clay or wood. Therefore, when the materials endow the object with a dimension, the shape is affected, since the properties of matter provide textures, volumes and geometries and, ultimately, a certain energy.

What is interesting about the example of the dolmen is the humility and sensitivity with which the creators approach the act of construction. The stone plays a leading role, telling a story with its composition, fracture points and cracks. In addition, its relationship with the environment is totally natural, since it is presented in its stable state in the place where it is located. Its transformations have been due only to carving work, without applying chemical or physical treatments. This stone allows and supports the growth of moss, moisture stains and cracks due to thermal oscillations. These processes, which from a modern view would be pathologies, actually give life to this material, which has a not insignificant persistence over time.

Architecture at the beginning was composed of materials from the ground, known as “technogenic materials” [3], which were transformed through simple processes. Technical advances throughout history would begin to produce increasingly complex systems. It was in the Neolithic when the first structures of wood and skins began to appear, which would later evolve as humanity developed metallurgical processes [4]. Initially, the drying of the earth in the sun gave rise to adobes, (see Fig. 1), which would the first architectures built by series production to be generated. The same

Fig. 1 Adobes (photography). *Source* Author 2013

happened with the carving of ashlars. The high point (from which the concept of modern materials arises to a large extent) appears with the firing of the earth and the first bricks, as well as with the firing of limestone to create lime. This marked a transition from taking advantage of materials in their natural qualities to transforming them to obtain others with better performance. But these transformations come at a price, as the natural stability of raw materials is broken, allowcreating new materials that are susceptible to degradation, rust, fracturing or disintegration. Only Roman concrete can be considered a material with the pretense to eternity, since its chemical and processing lead it to absorb the CO_2 lost in cooking and return to the original limestone, with improved properties conferred through the addition of additiphysicalves of volcanic origin [5]. The vast majority of the rest of the materials made from physical and chemical transformations, are doomed to disappear in a few decades if there is no maintenance work.

However, very soon coatings and plasters would begin to be applied. Greeks and Romans already covered stone walls with mortar or lime mortar. Classic Arab culture covered its buildings with finely carved plaster and earthen plaster. But we do not find systems more complex than these schemes. That is to say, basically the bare adobe or stone wall was changed to walls with a layer for decorative purposes and, in some cases, for protection of the system. These first architectures did not conceive of envelope systems by grouping layers of different materials, with the exception of roofs. The challenge of generating a waterproof space was superimposed on the purely structural one, with the need to create the support on the one hand and the waterproof system on the other. In the case of rainy climates, this problem has generally been solved through waterproof elements geometrically arranged in such a way that drainage occurs. This system initially used branches and leaves, which were placed in such a way that they allowed the evacuation of water by gravity, before being improved through the use of tiles or stone slabs, which allowed greater durability.

The development of complex construction systems, composed of various materials and with an elaborate technique, emerges according to contemporary concepts throughout the twentieth century. This is due to the appearance of new materials derived from petroleum, fundamentally plastics in various forms. Industrial research began to produce materials with great thermal insulation capacity, waterproofing capacity, plasticity and/or hardness. This allowed materials to specialize in a certain property, so that the construction systems that arose was made up of several layers.

Analyzing this historical process from an ecological point of view, it can be affirmed that prior to the first modern oil well, drilled by Edwin Drake in Pennsylvania in 1859, all architecture was sustainable from the perspective of materiality. The materials were sourced locally, they were very minimally processed and after their useful life they were easily absorbed by the environment. The appearance of oil as cheap energy led to industrial development and the advancement of transport technologies, which has been the seed of the current environmental and climate crisis on our planet. In the purely architectural context, the industrial development propitiated by this fossil fuel resulted in the appearance of air-conditioning machines, which allowed the bioclimatic aspects of buildings to be neglected. This twentieth century model, in which appliance technology prevails over design ingenuity, generates an increase in energy consumption through air conditioning, with consequential pollution. But oil also resulted in the creation of new materials from refinery waste, which generate pollution in their production and transformation process, and are also not acceptably biodegradable.

There are now attempts being made to try to reverse the dynamics of the last century of the last century, but commercial interests and the globalization paradigm do not leave much room for serious and comprehensive development. Another important obstacle is the fact that in order to obtain a system that meets the requirements of thermal insulation in materials within bioconstruction, elements with greater thickness are usually necessary. This supposes a loss of useful space in a building, a situation that can be challenging with land and real estate speculation.

Therefore, in order to deal with the problem of the globalization of materials and the decline of traditional materials, a profound change in the general conception of what architecture and habitability is necessary. For this reason, this chapter approaches materials from a more conceptual perspective, through a series of reflections on constructive sincerity in architecture and brutalism, two similar positions that focus on the use of bare materials.

3 Pure Positions in Front of the Material

Throughout history there are many examples of the application of construction materials in their pure state. However, during the modern movement these positions acquired special relevance. Architects such as Alvar Aalto, Louis Kahn, Mies Van der Rohe and Le Corbusier took this direction of constructive sincerity, but with conceptual nuances in their interpretation. There is also a much more pragmatic

architecture that reproduced this material paradigm of nakedness and honesty: the architecture of the industrial revolution. Unlike in the case of modern architects, it was structured through constructive sincerity for economic reasons, not aesthetic or conceptual ones. For this reason, our attention is focused on those proposals that are loaded with a theoretical reflection within architecture, since this chapter does not have aesthetic pretensions, but rather conceptual ones.

When reviewing the concept of constructive sincerity in the modern movement, it can be observed that architects associated with this approach were usually from Protestant environments, for whom perhaps moral precepts (such as sincerity) influenced conceptual understanding of the material [6]. There are two prominent positions in the modern movement regarding the way of understanding the pure use of the material. On the one hand, we find Mies van der Rohe, who had a rationalist and dominating interpretation of the material. On the other side, there is Le Corbusier, whose brutalism proposed a freer and more expressive way of understanding the material, allowing it to have certain degrees of freedom. Both endow material and technology with a conceptual meaning, expressing their qualities through their solid exposure in the project, however, their personalities and ideologies produced disparate approaches. They have in common the search for authenticity (which is a more appropriate quality for a material than that of sincerity), and the emphasis on the material being central to the design of a project.

This way of understanding the material through its inherent qualities, generates a conceptual architectural position that is not linked to space or understood geometrically, but instead to Peter's concept of "atmosphere" [7]. This idea, closely linked to that of Steven Holl's "phenomenology" [8], results in a theoretical revolution in the understanding of architecture. Both coincide in understanding the project from a perspective that prioritizes the viewers and their experience, through resources such as sound, touch or temperature. For them, what is relevant is not spatiality through a coordination of geometry and light, but the sensory experience. However, this does not mean that form and volume are ignored, on the contrary, a whole is created that enlarges the holistic system of architecture.

Although these principles have been widely used in history—a clear example is classical Arab architecture- they had not been explicitly described until now. This development, carried out through praxis and not theory, had its break from the phenomenology of the modern movement, which laid a series of conceptual foundations that were based, to a large extent, on geometrical, technical investigations and on the inclusion of state-of-the-art technological materials. In the vast majority of modern examples, memory, history, culture and the environment were ignored, as was as the recreation of the senses through architecture. The phenomenological themes were hardly developed, with focus instead on the lavish exhibition of technical, volumetric and compositional achievements. The senses were not the central theme, although many architects, such as Frank Lloyd Wright, Luis Barragán and Óscar Niemeyer, worked on these issues in a heterogeneous and personal way.

This situation has not been analyzed in the main treatises of the modern movement, since the euphoria and admiration for the new architectural model left little room for this type of criticism. But the its basis was created around two thousand years

ago, through the most modern of antique cultures: Rome. Vitruvius exposed through his treatise some very positivist and materialist principles, which are still studied in architecture schools: firmitas, utilitas and venustas [8] or 'solidity, utility and beauty'. It seems like a comprehensive description of the pretensions of contemporary architecture, where themes such as the social, the poetic, the phenomenological or the symbolic are conspicuous by their absence. The recovery of the treatise "The Ten Books of Architecture" [9] during the Renaissance, caused the development of all subsequent architecture in Europe and America to abandon the principles of phenomenology that had been applied, for example, in Gothic or in Arabic architecture. In addition, the canon of beauty from the classical orders was considered valid and exclusive, through deep geometric and mathematical studies, which have an irrefutable value, but which cannot be considered in a unique way.

The modern movement was presented as a break from all these aesthetic orders established in the Antiquity and the Renaissance, which had been evolving throughout history through styles such as baroque, neoclassicism or picturesque. This split occurred, as in most artistic historical changes, through a denial of a general quality of the former. In this case it was denying styles as a paradigm, symmetry and ornament. However, this denial continued to work within the same concepts as the previous one: firmitas, utilitas and venustas, only modifying the concept of what is now beautiful, which nevertheless continued within aesthetic, compositional and geometric concepts.

The great innovation produced by the modern movement was the inclusion of the conceptual as an element in the creation and formalization of buildings. When the concepts transcended, connections with the phenomenological were produced, but which were not subsequently reflected upon or discussedby their authors, as if the achievement obtained escaped the need for any explanation. This was the case with the Barcelona Pavilion by Mies van der Rohe, a pure expression of poetry by the quintessential rationalist of the time. Memory through sculpture, spatial silence, theatrical dialogue between materials, the water. An act of artistic expression sprang from a paradoxical discourse, in which the supremacy of the human and the meticulousness of the technique prevailed, and in which there was no room for sensory or experiential reflections. On the opposite side, we find another example of extreme expressiveness that produces phenomenological experiences, despite the rigidity and rationalism of its program: Le Corbusier's Unité d'Habitation in Marseille. With an unbridled and revolutionary force, Le Corbusier proposed the first brutalist building, in which he riskily experimented with a completely new and expressive conception of the material, enclosing profound reflections on what architecture is in its essence and connecting it with sculpture. In this case, there was no theoretical discourse on the part of the author about this discovery, and practically none by subsequent critics and historians.

These "coincidences" obey deep impulses of the soul, which are not easy to rationalize or explain, and even less at the time that they occurred. However, Zumthor and Holl enter fully into these topics. They begin to be interested in aspects of architecture seen from their perceptive self, and not from an erudition based on references and

comparisons that is, from a simple delight in form. This phenomenological and atmospheric vision is adequate to understand the conceptual consequences of materials in architectural projects, which amplify their role through the symbolic messages they can transmit and the sensory experiences they can generate.

Thus, the material is not a means to build a space, but it is one of the great themes of architecture.

4 The Material in Bioclimatic Architecture

Bioclimatic architecture has its essence in traditional architecture, as well as in the trial-and-error methods. The absence in antiquity of rapid means of transport and production conditioned those systems to develop through the use of locally available materials. However, the evolution through empirical developments were generating optimal solutions for a place and its conditions. In this sense, the material becomes relevant through its thermal properties, (a crucial factor for comfort), or its geometric or mechanical qualities (for sun protection or ventilation solutions). Sometimes the earth provides the conditions of insulation and thermal inertia (such as in very hot and dry or cold climates), other times it is materials like bamboo that allow the creation of models that prioritize ventilation in hot and humid climates. As has been said before, the architectures prior to the industrial revolution, which have evolved over time, were optimal for their environment.

The appearance of globalization restricted the use of traditional systems in developed countries, further fueled by a theoretical position of the modern movement that denied these systems. Eurocentric cultural concepts were applied to construction materials, dismissing the vernacular as weak, perishable and characteristic of a lower class. This generated a dynamic of downplaying ancestral architectural knowledge, which ended up putting all vernacular architecture in serious crisis.

Globalization generates materials that can be replicated throughout the world, produced in large quantities and at low economic (but not environmental) cost. This relegates traditional materials to underdeveloped areas and, in the case of developed countries, to almost complete extinction. This means that knowledge of vernacular techniques and production methods is lost in the latter, thus becoming a product of low or no demand, which in turn makes it difficult to execute a modern building with traditional techniques. Suddenly, building with natural materials from the environment becomes a luxury product, which requires great economic effort for its execution.

Tradition shows us wisdom of great value through vernacular models, in which the properties of the materials used in the area and the design itself are connected. One and the other conform, resulting in an optimal interior environment for the climate where they are located. The adobe houses of the Sahara Desert cannot be conceived of with any other material, since its thermal inertia allows it (through a correct dimensioning of walls and openings) to exchange the energy of the day (very hot) and that of the night (very cold) in the interior through thermal delay. If the

material is changed, this exchange does not work; and if the geometry of the spaces and the thickness of the walls are not correct, it does not work either. This relationship is lost in modern models, in which there are insulation and optimization strategies designed for air conditioning systems.

There are incipient industries recovering some of the traditional techniques and materials, and in many cases interpreting them in a modern way- the question of heritage forces the actors involved in the interventions to confront these technologies, though not always in the right way.

The industrial material predominate over the natural, though only due to its economic advantages (Fig. 2). On moving past the primacy of monetary materialism, natural materials assume immense value, such as through the benefits for health, since traditional materials do not generate harmful products or diseases. This is not the case of industrial materials, especially those derived from petroleum, which, apart from the large amount of embodied energy, in some cases produce volatile substances and residues in their degradation that are polluting and harmful to health. For example: cooler wall surfaces can facilitate emissions from chemical wall paints; while moisture in concrete allows alkaline degradation of di-ethyl-hexyl-phthalate (DEHP) (the plasticizer of vinyl flooring) [10]. In-depth studies are needed on the health implications of the chemical envelopes that our modern living spaces create- but of course history and empiricism have already shown that earth, wood or lime have no harmful effect.

All vernacular architectures have managed to develop models adapted to their environment with the raw material found there. Regarding the bioclimatic adaptations, at times the thermal inertia is used, in others the insulation, and in some the

Fig. 2 Byo-contruction system through compressed earth block and hemp insulation (photography). *Source* Author 2011

capacity to create ventilation or solar protection systems. Currently there are means to further optimize the benefits of these materials and create new ones, through certain industrial processes or construction systems. However, the large investments in research necessary are not directed in this direction, but rather toward chemical development through petroleum residues and chemical industries. Gama-Castro et al. [4] affirmed, referring to technogenic materials, "the scarce theoretical-practical knowledge that the Earth Sciences have about their composition, characteristics and properties is surprising".

But not all the advantages are from a scientific and measurable point of view. There is a subtle background and pertaining to the field of lived experience that influences the atmosphere of a living space. Being in an adobe room is not the same as being in a concrete room. Materials have their own energies and evocations that influence the observer's perception. The natural material tells its story and is alive. Adobe buildings have a characteristic odor that is given by the land of the area used. The character of wooden or bamboo constructions show in the pieces, the knots, the rings or the chromatic differences of the organic fibers. Stone constructions show veins, color differences, porosity and differential hardness. All this participates in the construction of the aforementioned idea of "atmosphere". That is to say, it is not only the form and the aesthetics, but also the silent messages that the matter transmits. And in the case of natural materials, this message is full of life, of atavistic recognitions that are embedded in our existential DNA.

5 Constructive Authenticity and Bioclimatic Architecture

Constructive clarity has been applied in bioclimatic architecture in an irregular way. There are examples that are clearly ascribed to it, such as igloos, stilt houses or houses in the Atlas Valley in Morocco. In these cases, the material is solid, without any kind of coatings or paint. But there are also numerous cases of vernacular architecture that work with coatings or paints. The cultural aspects or the protection requirements of the base material generate these solutions. Earth plastering, lime plastering, and ceramic coverings are a few examples. However, they do not normally aim to improve the thermal behavior of the system, so for bioclimatic purposes they are dispensable.

The possibility of working with efficient construction systems that at the same time develop constructive sincerity, is limited by the climatic conditions of the environment and the available material. Extreme climates do not allow for the creation of this type of solution, since modern regulations dictate that different layers and components are necessary to obtain acceptable comfort. This is largely due to the reduction in tolerance and social acceptance for certain living conditions, which are seen from a contemporary perspective as an attack on the fundamental human rights. This would be the case in the example of the aforementioned igloo, which is a successful solution in extreme cold weather that manages to create an internal environment of up to 40 degrees Celsius more than the outside, but never at a temperature higher than 10 °C,

so for decent housing purposes it does not seem like an acceptable option. The development of global dynamics, consisting of the application of space heating and cooling technologies—such as air conditioning or fossil fuel boilers—has focused the issue on energy saving, assuming that a machine is necessary to obtain comfort. This is what happens in the Spanish standard of the Technical Building Code (CTE), where the checks required for compliance with the DB-HE (Energy Efficiency) require, through simulation programs, the placement of an air conditioning system, without giving the option to manage comfort through bioclimatic strategies.

The possibility of applying constructive authenticity to bioclimatic architecture depends on several factors, but if it is considered that in many climates it is necessary to include an air conditioning system to obtain comfort, then following the strategy of thermal insulation and inertia can require going against popular consensus.

In order for a material to be applied according to its constructive authenticity and meet the comfort requirements, it is necessary that it meets the structural, insulation and inertia conditions of being self-supporting and that it meets the requirements of insulation or thermal inertia, as well as being capable of mechanically supporting the environment.

The 3 fundamental materials without industrial transformation that have been used most profusely throughout history have been raw earth, stone and wood.

In terms of material properties, it is raw earth that has the greatest advantages of the three. Earth is available in 90% of the inhabited areas of our planet, and can be associated with other materials that complement it to create the construction and structural system that will make up the building. Adobe or rammed earth walls do not require cladding if they are properly protected from contact with water and humidity; however, they do not work in very hot and humid climates due to their great hygroscopic capacity. But there are modern techniques that can stabilize these systems, through natural materials such as lime. Earth is a good insulator, even better when combined with straw, and it also has very good thermal inertia. Its texture, its chromatic possibilities and its touch make it an ideal material to generate phenomenological experiences, while in many cultures it is a symbol of the ancestral construction tradition.

Stone can be used in its inherent materiality as long as the climate is not too cold or too hot, since its great thermal inertia capacity also makes it a conductor when the difference in temperature between the inner and the outer surfaces is very large. With appropriate thickness of the walls and control of the permeability of the enclosure, a very suitable solution for temperate climates can be obtained. Its properties of solidity, permanence and hardness had fascinated ancient cultures, making it the material of choice to raise the great historical buildings. As with earth, stone exists in a great variety of textures, colors and densities, which gives it great expressive possibilities when applied in architecture, since it also allows different forms of carving and modeling.

Wood has very good thermal insulating properties, although the direction of the wood fibers in relation to heat flow must be taken into account. The thermal conductivity of the woody substance in the longitudinal direction of the fibers is h = 5.62 kcal/m h °C and in the perpendicular direction h = 0.362 kcal/m h °C [11].

It is not a suitable material to create isolated spaces in hot and humid climates. Being a living material gives wood a specific and particular character, as well as much more limited durability than the stone and earth, even with maintenance. For expressive purposes, wood provides warmth and a welcoming atmosphere to human habitations.

In all three cases, thickness is essential for insulation and thermal inertia requirements, which are greater than if we use mixed systems with chambers or layers of highly insulating materials. Therefore, in the vast majority of cases, the significant space requirements of natural materials, when compared to the use of insulating layers of other materials, becomes a problem in built up areas.

Modern bioclimatic trends are excessively focused on achieving the objective parameters of sustainability, while ignoring in the most cases the expressiveness and commotion that architecture can create. We also find false bioclimatic buildings, in which some sensational resource has been applied such as green facades, terraced gardens or a huge number of solar panels neglecting the fundamental parameters of material sustainability in building components. However, they are still sold as green and environmentally friendly architecture.

But there are honorable examples of projects that have worked along the two lines described, seeking a bioclimatic strategy and at the same time managing to extract expressiveness and phenomenology through the material. A case in point is the Toro Pool in Spain, by VIER Arquitectos. A brutalist approach was taken through an interpretation of the rammed earth system and vernacular material of the area, which interacts with another much more contemporary one- exposed reinforced concrete. The dimension of the purely bioclimatic, both in the recyclability of adobe and in its thermal properties, transcends through the exhibition of the material without any coating, showing the layers and evidencing how it was built. There is in this a sensory experience that connects with the nature of the land that makes up the wall, but also with history and memory, through the construction method it represents. The concrete provides the counterpoint. It is not a bio material, but it has mechanical characteristics that can hardly be obtained with other materials, even more so due to the scale of the building. This concrete is presented in the Le Corbusierian manner, just like the rammed earth, establishing between the two a magnificent debate on what is modern and what is traditional. The skill of these architects has led to a result that works, that is not radical and that transcends through the use of the material.

Another example of raw earth is the Hotel Tierra Atacama, in which a rammed earth construction system is developed, inspired by an old ruin existing in the desert where it is located, an area with the lowest annual rainfall in the world. The architectural interpretation is also made from a modern vision, through the geometrical prisms where the rooms are. The adobe is presented without coating and without rain protections, since the rainfall regime is null, and the risk of water absorption does not exist. The architects of this project took advantage of the climatic conditions and the available material to create an optimal high temperature insulation system, and at the same time proposed an unusual construction solution, in which the raw earth was exposed to the environment. As in the Toro Pool, modernity and ancestry converse, generating a stimulating result that blends the future and the past.

Ecuador has climatic characteristics that allow, in most of the inhabited areas, comfortable conditions to be attained through the use of natural materials and bioclimatic strategies. For the Sierra region, raw earth is the most suitable, since its climate (temperate with cold periods and a general drop in temperatures at night), allows the establishment of strategies of thermal insulation and inertia with sensible wall thicknesses. In addition, there is a tradition, pre-Columbian in some cases and colonial in others, of building with this material, which is abundant in the environment. Therefore, in the collective memory, adobe has a meaning, it is a known material that survives in some heritage buildings. The climate of cities in the mountains, such as Quito, Cuenca or Loja, allows the surrounding system to be solved only with this material, without the need for superimposed insulating layers. The use of this material in a solid way and without coatings represents a great opportunity for architects, since its expressive and symbolic possibilities will open projects towards more ambitious goals in the conceptual and bioclimatic aspects.

In the coastal and Amazonian regions of Ecuador, characterized by a tropical, humid-warm climate, the materials that work best are guadua cane and wood. In this case, insulation strategies are counterproductive, since the internal thermal loads of the house would cause overheating. The only plausible strategy is ventilation, so that the thermal loads dissipate. And so it has been for centuries in these areas, through stilt (or semi-stilt) solutions that promoted ventilation under the floor and under the roof. These constructions have been developed using wood and guadua cane, without the need for coatings or extra layers. In the eastern Ecuadorian area, buildings are built in many cases with brick or concrete block, keeping the chamber ventilated between the roof and a false ceiling that covers the habitable area. For thermal purposes, brick or block do not contribute to comfort, so the recovery of wood construction techniques would not mean a reduction compared to the previous ones. This material is very abundant in the area and offers excellent properties if it is properly protected from xylophages. Its exposure in its natural texture does not offer any technical problem in its durability, so it becomes an option with great possibilities for design.

Therefore, both in Ecuador and in the rest of the world, vernacular architecture can show us what to build with and how to build.

6 Conclusion

The challenge of taking advantage of the expressive properties of materials through a solid conception of the material and at the same time obtaining a comfortable building is possible. That is, the shortcomings of modern buildings that applied constructive authenticity, whether Miesian or Le Corbusier, in terms of climate and comfort can be remedied by opening these concepts to natural and traditional materials. This supposes the appearance of bioclimatic brutalisms, as in the case of the two buildings discussed in the preceding section, and also opens for investigation the processes of degradation and naturalization that these materials can suffer. This is another

conceptual aspect of great importance, since, if the interpretation of the material is in its natural state, maintenance interventions must be carefully designed and carried out, since its alteration would cause a loss of meaning in the building.

The Ecuadorian case, from the perspective set forth in this document, offers a great and valuable opportunity to work in both directions of the material's discourse: the conceptual and the sustainable. History and memory help feed the desires of the new project, providing the guidelines of the traditional wisdom accumulated in times past, but also allow the interpretation and investigation of new models, which maintain the identity and meet the requirements of comfort and sustainability.

Ultimately, everything comes down to the effort of creating good architecture, in all dimensions, since if we focus on just one part, the other parts suffer. Either the building doesn't work well with the weather, or the building misses the opportunity to create a sensory, emotional, and intellectual experience.

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