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ECOVILLAGE AND HYPERADOBE FOR SOCIAL INTEREST ARCHITECTURE

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Abstract: Housing production in Brazil faces historical problems of deficit and denial of access, at least since 1850. Despite being a constitutional right, the housing policies that promise to combat the deficit are not very concrete, mainly due to the lack of understanding that the right to housing is also the right to the city, transportation and a dignified life. Earth, as a material, consists of the oldest constructive element of civilization, with Hiperadobe being a constructive method using earth in a monolithic system, pressed in HDPE bags, in raschel mesh, created by Fernando Pacheco, in 2010. objective to enable and propose the resumption of vernacular construction techniques aligned with new technologies, where bibliographical research and laboratory tests prove that the soil is an excellent constructive material. The high ecological and monetary cost of industrialized materials harms the environment and the low-income population's access to housing, making ecological alternatives, such as land, present themselves as a good habitat constructive method, with hyperadobe being a typology of low cost and easy social appropriation. Ecovillages are niches for innovation and sustainable experimentation, ecosystems based on collectivity, treated as an alternative to housing production beyond the immediacy of quantity and the isolated unit. An Ecovillage of Social Interest, treated under a collective property bias, shows itself as a possibility of creating non-commodified or financialized housing.

Keywords: Hyperadobe; Ecovillage; Sustainability; Vernacular Architecture; earth construction.

HISTORY AND CONCEPT

> In antiquity, the first architects kneaded the earth with their feet, to prepare the bricks. Barefoot architects treading the earth, a distant image of our reality that moves further and further away from nature (VAN LENGEN, 2021).

According to several authors consulted by Alves et al (2021), Weimer (2012), Eduardo Bonzatto (2010), Josué Benvegnú (2017) and Gernot Minke (2005), it is estimated that about a third of the world lives in housing produced with land, and in underdeveloped countries this number grows to about 50%. You can find examples of earth building as old as those dating back to 9000 BC. in Palestine (PROMPT; BORELLA, 2010) and there is evidence of compressed earth in constructions dated between 8000 BC. and 6000 BC, in Turkestan and Assyria with dates from 5000 BC. (MINKE, 2005).

Newer constructions, such as those from the 17th and 18th centuries, made with earth, are still standing in Brazil and in colonized countries, and there are still some remnants of constructions in Europe and North America. In England, for example, there are records of houses made of rammed earth with up to five floors (BENVEGNÚ, 2017), in Germany, the oldest building using earth in its construction dates back to 1795 (MINKE, 2005).

As earth is a highly versatile element, having a variable composition, several construction methods with soils have been developed by the most diverse cultures in the world (BENVEGNÚ, 2017). Minke (2005) reports that in Mexico, Central America and South America, most of the original peoples already knew and worked with rammed earth, and those who still did not were introduced by the Hispanic invasion and colonization. The adaptability of the earth makes it, perhaps, the constructive material of the greatest technological experience that we have, even if part of this knowledge has been erased by the desire for industrial advancement. According to Jüguen Schneider (WEIMER, 2012), all civilizations have built works with earth.

Most of the construction inputs in the countries of the Global South, today, are based on the manufacture of technology with a high energy and ecological cost and generate too much waste in construction (GOULART et al, 2011). In addition to the high cost caused by the industrialization of materials, which make it difficult for a large part of the population to access such products, it also helps to explain that, in underdeveloped countries, the rates are 50% of homes with soil.

At the end of the 19th century, the newly formed republic of Brazil, steeped in the European illusion of progress and development, prohibited construction in rammed earth and its craftsmen were persecuted until they disappeared (BONZATTO, 2010). This forced the "developed" baked brick and concrete market to enter a Latin country with a tropical climate, which exchanged the natural, regional and ecological style of building, for subordination to the standards of the global north of production and neocolonization.

The civil construction sector is one of the most predatory activities of the environment, making bioconstruction a highly suitable aspect for the production of architecture (PROMPT; BORELLA, 2010). In industrialized countries, the excessive exploitation of natural and human resources and the capital- and energy-intensive production system generate too much waste and contaminate the environment (MINKE, 2005). According to Zimmermann et al (2015), "the hegemonic development model has been leading humanity to a high urban concentration with cities built based on industrialized resources, obtained and produced at a high environmental cost". Also, according to the authors, the resource base that made possible the growth and development of civil construction activities in a gigantic way, in the last two centuries, has been gradually becoming scarce and its extraction and mining are responsible for a large part of the environmental destruction.

Bioconstruction and ecovillages are part of an expanded vision of the energy movement, natural resources and needs (AZEVEDO; DUARTE, 2018). The ecological concern of the construction is understood, from its design state, construction, to the post-occupation and demolition of the building, always using materials that are in harmony with the inserted environment (SCHULTE, 2020).

Zimmermann et al (2015) highlights three important aspects for bioconstructions: the construction, the relationship with the environment and the effect on the health of users. The construction stands out for its minimal energy expenditure for this work, the use of local materials and the low environmental impact; the relationship with the environment stands out for its energy efficiency, bioclimatic adequacy, adequate insertion in the location, correct use of water and waste treatment. The effects on health, bioconstructions, ensure adequate ventilation and lighting by the principles of bioclimatic architecture, as well as the earth can serve as an insulator of electromagnetic waves dissipated by electronic devices and the ability to absorb and neutralize chemical products.

Bioconstruction values local materials, and in regions without forests, it is preferable to use soil as a building material.

Zimmermann et al (2015) highlights the use of raw earth for civil construction instead of fired bricks because:

> Unlike brick, it is used in the original state, it does not go through the burning process that transforms clay into ceramics. Thus, in addition to not wasting energy, it does not generate pollution by burning the fuel; another reason is that with raw earth procedures are used whose aggregator is also earth or another natural element, without the need for cement or sand extracted from rivers or their banks; another factor is that the raw earth will be extracted from the construction site or very close to it, which would be difficult to do in the case of ceramics. That is: the raw earth will always be a local resource while the ceramic brick will always be produced in the market.

GENERAL INFORMATION ON EARTH CONSTRUCTION

The earth, technically called soil, is the product of the decomposition of rocks, mineral and organic elements (AZEVEDO; DUARTE, 2018) and can serve as a base material for the elaboration of elements and construction techniques. Buildings with soil can be further divided into three major systems: (a) monolithic systems, (b) masonry systems and (c) filling and coating systems (BENVEGNÚ, 2017).

Among the forms conceptualized under the monolithic system, excavated, plastic (such as wattle and daub), stacked (Cob), molded and pressed (such as rammed earth and hyperadobe) stand out. As for masonry, it is understood by pounded, pressed and cut blocks, clods of earth, mechanical, manual and molded adobe. As a filler for the support structure and coating, covering earth, earth on a crate, straw earth, filling earth and covering with earth can be considered. Monolithic constructions are more durable than constructions of other types, such as adobe.

Building on Earth:

> It is a "soft" technology, where knowledge contributes to talent and is easy to learn for builders, as it has minimal requirements in tools and low cost, and thus allows appropriating and transferring technology, and adapting the technique (...) to the context (...) (GARZÓN, 2015).

Although Garzón focuses on bahareque constructions, the same can be said about hyperadobe buildings, given the constructive and mechanical similarity of typologies in the transfer of continental regulations from Latin America to the context of Brazil.

For construction with earth, the soil must respect ideal physical and chemical conditions for each typology, such as the granulometric composition, plasticity, shrinkage and execution humidity (BENVEGNÚ, 2017).

Due to the characteristics of physical resistance and comfort of the earth, its low cost and sustainable characteristics such as environmental and social (SILVA, 2019), important advances have been taking place in this area with regard to the study, documentation and promotion of architecture with earth (GOULART et al, 2011; DIAS, 2015).

> Some advantages of using soil as a building material are: regulation of humidity and temperature inside the building; absorption of airborne contaminants; radiation filtering; resistance to fire and its propagation; earthquake stability performance; some systems have structural capability; its low environmental impact production, as the material is 100% natural and reusable; the construction techniques are easy for popular appropriation; and, finally, agility in execution and high performance on the construction site. (ALVES et al, 2021, our translation).

The earth holds better quality indices in terms of environmental comfort than most industrialized materials, such as cement, tiles or sand-lime elements (MINKE, 2005). The earth walls control the humidity and temperature of their surroundings through their intrinsic transpiration capacity of this typology. Thanks to their great thermal capacity due to their excessive mass, hyperadobe walls, for example, guarantee great thermal inertia, creating a better microclimate of the residence and favoring its use in the most diverse regions of the country, obviously, with local feasibility analysis. Likewise, the walls will ensure acoustic insulation, due to their expressive mass, along with quality frames and coating, providing an excellent acoustic effect.

In tests run on: *Forschungslabor fur Experimentelles Bauen* (FEB) from the University of Kassel, Germany, demonstrated that the moisture absorption capacity of an earth wall is thirty times higher than fired bricks, if the relative humidity of the air rises from 50% to 80% (MINKE, 2005).

On the other hand, FEB research shows that earth walls absorb less water by capillarity than common fired bricks (MINKE, 2005). It must be noted that when the soil absorbs water, it expands, which may harm the physical and chemical structure of the wall, however, as the studies show, the low absorption coefficient of earth walls guarantees the structural stability of the building (MINKE, 2005).

The earth is a great heat store, excellent in thermal inertia for areas with very high thermal amplitudes, making a climatic balance inside the building (MINKE, 2005). The specific heat of the earth, that is, the amount of heat required to heat 1 kg of material by 1°C, is 0.1 kJ/kgK, or 0.24 kcal/kg°C. The heat capacity is the amount of heat required to heat $1m^3$ of material, defined by the product of its density and specific heat. The heat storage capacity is calculated by the product of the specific heat, density and thickness of the element (MINKE, 2005). A wall with a high thermal storage capacity delays the transfer of heat and decreases the thermal amplitude of the environment, and the thermal capacity is important in creating a healthy and comfortable environment. The U value (heat transfer coefficient) of a 30cm thick pressed earth wall is $1.9W/m^2K$ to $2.0W/m^2K$.

The energy cost of building with earth, according to Minke (2005), is 1% of the energy cost of preparing, transporting and making concrete or fired bricks. It is also possible to highlight, as an important factor, the life cycle of earth constructions, when at the end of the life of the building, natural materials are reintegrated into the environment, minimizing the serious problem that is construction waste (PROMPT; BORELLA, 2010). Clay will never be debris that contaminates the environment (MINKE, 2005).

Soil acidity varies between 7 and 8.5 pH, and may vary according to the region collected. pH greater than 7 prevents the proliferation of fungi, which prefer environments between 4.5pH and 6.5pH (MINKE, 2005).

The recovery of knowledge in building with earth, especially of a popular nature, is, as Eduardo Bonzatto (2010) puts it, much more than a mere economic or aesthetic gesture, it is, above all, a political gesture, which opens up to autonomy and independence, without giving up comfort and beauty, having an ancestral quality of life.

Civil engineer Josué Benvegnú (2017) argues that construction with earth has been gaining ground again and, in several areas, such as residential buildings and teaching places, striving for the sustainability that bioconstruction can offer.

HYPERADOBE AND ECOVILLAGES

A research carried out by Librelotto, Telli and Ferroli (2016), through VirtuHab of the ''Universidade Federal de Santa Catarina", analyzed 27 constructive typologies that could be applied to social housing with a sustainable bias. Among the best scored by the survey, Hiperadobe and Taipa de Pilão stand out, tied for second place.

At least since 1978, there is a record of the use of the technique of bagged earth and sand, however, it only began to spread from 1984 onwards, when the Iranian architect Nader Khalili, after patenting the technique, began to spread it across the country. world. Khalili named the technique earth-bags, however, it became better known as superadobe. The technique uses raffia polypropylene (PP) bags with barbed wires between the rows (AZEVEDO; DUARTE, 2018). Superadobe has the initial characteristics of adobe blocks, however, executed similar to rammed earth.

Hyperadobe is a typology of construction with earth, created from superadobe, by the Brazilian engineer Fernando Pacheco, in 2010. Basically, it consists of using raw and humid earth to fill mesh high-density polyethylene (HDPE) bags raschel, which will be compacted with a socket in loco, and each row is compacted individually, until reaching the height stipulated by the project. The raschel mesh has a greater advantage over raffia bags, as the greater spacing of its fibers allows greater roughness for plaster application and does not require burning the bag, a common activity in superadobe, in addition to not needing barbed wire between rows, as the bag itself generates enough texture to be stable (BENVEGNÚ, 2017). Hiperadobe is a low-cost, high-performance typology that stands out for being easy for social appropriation (ALVES et al, 2021).

Hyperadobe also presents other advantages, such as the absence of the need for vegetable fiber, it does not need to wait for the layers to dry before the execution of the masonry sequence and, depending on the soil, the typology itself can be used as a foundation (HUNTER; KIFFMEYER, 2004, apud BENVEGNÚ, 2017). However, the large wall thicknesses can be obstacles in terrains of reduced sizes or the lack of hegemony of the soil that will be used.

Buildings in superadobe, similar to hyperadobe, in São Paulo, save 13% compared to concrete blocks. If the land used is local, the savings rise to 18% (DIAS, 2015). According to SADCSTAN (2014), constructive simplicity and the lack of specialized labor make the rammed earth construction method an important tool in the production of low-cost housing. Taking hyperadobe into account, these characteristics will only improve, since the constructive production of this technique is even greater, compared to rammed earth.

> Constructive solutions linked to bioconstruction can be considered social technologies, allowing the local community to interact with housing construction, as well as promoting social transformation and community empowerment. (SCHULTE, 2020).

In this context of modern society, with little or almost no construction of houses on land, ecovillages must be considered as spaces for social and technological experimentation, in order to study in loco and contemporary use of these communities to minimize the housing deficit in civil construction. popular housing. Ecovillages are too old, however, this term begins to be spread worldwide after the 1990s.

Roysen and Mertens (2018) cite the characterization of "ecovillage" as being a grouping that promotes ecological sustainability through lifestyle changes, with the use of sustainable construction and cultivation techniques and by the effort to reduce its environmental footprint.

> Ecovillages are a grassroots innovation niche, composed of intentional communities that develop innovative practices related

to the environmental, social/community and cultural/spiritual dimensions of sustainability (BOYER, 2015, 2016; KUNZE, 2015; ROYSEN; MERTENS, 2016 apud ROYSEN; MERTENS, 2018)

Its members also establish a sense of community, forms of cooperation and solidarity among people, being participatory and democratic in decision-making, as well as encouraging personal development, valuing cultural change as part of the search for a more sustainable world. The users of these places, in the elaboration of their daily activities, learn, in practice, sustainability and care for the environment (VIEIRA, 2020). Local development always requires mobilization and social initiatives in the face of a collective project (BUARQUE, 2002). Processes related to bioconstruction stimulate social relationships, as they are spaces for exchanging knowledge and mutual help. This process is of fundamental importance for life in rural areas, and the exchange between neighbors and family members is part of the way of life in communities. Training comes along with the processes of bioconstruction, since knowledge of construction technologies is required by builders. Training activities are carried out, most of the time, together with the pioneering experiences of each community. Therefore, joint effort activities are encouraged that favor mutual cooperation and sociability within communities (PROMPT; BORELLA, 2010).

Ecovillages must function as units, as organisms. In Barda's classification (2009), to call the set an organism, one cannot remove or add without altering the existing balance. Far from becoming static, organisms evolve, however, they must maintain rules of composition in order not to break with unity.

Although little studied or legitimized in broad sustainability debates, ecovillages present and develop innovative practices and technologies that are of paramount importance in social ecological development (ROYSEN; MERTENS, 2018). Schulte (2020) comments that the ecovillage alternative stands out as a sustainable model for 21st century cities.

FINAL CONSIDERATIONS

The advantages of Hiperadobe as a proposal for social housing are potentially strong enough to require and justify investments in research and development, regulation and public housing policies that use earth construction (ALVES et al, 2021). In the quest to overcome the current constructive standardization, which proves to be extremely ineffective and, even worse, generates other extremely important urban ills, such as socio-spatial segregation and the lack of quality in habitat production. This dynamic of the excluding and segregated urban model creates a landscape in which survival strategies that destroy vegetation cover and favor the deterioration of the urban environment prevail (JACOBI, 1999).

The rediscovery and restudy of popular techniques and systems is a form of resistance against the modern and mercantile production of urban space, which goes beyond the production of space and form, but which brings with it the maintenance of ways and styles of life, experiences and spatial social organizations (BARDA, 2009). However, the absence of the State in sustainability and bioconstruction policies causes a rupture in the development of these constructive techniques, many still without national regulation.

With the high level of consumerism, associating the quantity of consumption with the quality of well-being in the capitalist logic, sustainability is, above all, public, social and economic policy, which depends directly on the desire of constituted States in its applicability. Bearing in mind that, according to Mioto (2015), neoliberalism is incapable of promoting persistent and equitable growth, families in vulnerable situations will then find it difficult to go through other means to obtain their rights, such as home. These other means enter the area of collectivity and mutual aid, still very out of context with the characteristic of the Brazilian individualistic society, which makes bioconstruction, especially in the context of ecovillages, rich experiences of a way of life that contrasts with the material reality of the city. The current individualist community that is formed in modernism and hangs in the postmodern, is a society marked, radically, by social inequality. The State is an indispensable means for correcting or accentuating the privileges of the ruling class (VIEIRA, 2020). Those who build in alienation from the political context are wrong, since architecture and urbanism are configured as the maximum expression of the dominant ideology, and this area is responsible for generating symbols of revolt and change. Lina Bo Bardi's position is reiterated here: there is no architecture outside political structures.

The bioconstruction, in the parameters that are currently presented, needs an individual who holds the feeling of belonging to its nucleus, that is, the entire construction must be connected, still in design, with the environment that will be inserted, with effective and active participation of the community. Current bioconstructions reconcile popular knowledge of habitat production with new techniques and technologies, ensuring better use of built space within the scope of sustainability. Through bioconstruction, it is possible to create collective spaces that are sustainable, comfortable and that respect nature and its surroundings, preserving natural resources, already scarce, for future generations.

The destructive performance of the capitalist world system is already clear, portrayed since its early days of the Industrial Revolution by Engels (2008), in: *Die Lage der arbeitenden Klasse in England*, released in 1845. The Situation of the Working Class in England (2008), still presents unique urban studies on the construction of the capitalist city, urban segregation and peripheralization, being one of the first works presented on the subject and which is still valid. Since at least 1906, there have been reports by social theorists and naturalists that "increasing human dominance over the Earth was giving rise, contradictorily, to a greater potential for ecological disasters on a planetary scale" (FOSTER, 2020, author's translation).

Engels had already predicted that there may come a day when humanity's struggle against the adverse conditions of life on the planet will become so severe that further social evolution will become impossible, referring to the eventual extinction of the human species. 2020). The current world system demonstrates exhaustion and exhaustion, that the makeup level under capitalist aegis no longer supports contradictions and slowly collapses. As much as the right to housing, food and education is theoretically recognized, and the reality is cruel and adverse, showing the incapacity of the capitalist State to comply with its own legislation, therefore, there is a need, not only to demand the fulfillment of rights, but to literally fight for them, to act in what the State is incapable of, in a collective, self-managed way to remedy the ills created and maintained by the constituted State.

The city itself is an irreplaceable factor of socialization and, only it, can offer an ecological matrix capable of making possible the development of an economy of exchange and post-monetization (SANTOS, M., 2012).

The problem, paraphrasing Milton Santos (2012), is to discover the infernal mechanisms of the production logic of cities, in order to propose and build another one. It is not possible, according to the author, to delve into details or aspects without understanding the parts, without knowing and understanding the whole, and this understanding of the urban whole goes through political economy, today and always.

The alienation of work, production and nature itself by human consciousness can lead to the destruction of every known society. The return to the understanding of an indivisible world between nature and society may be configured as the only means of survival over time for the human race and planet Earth.

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