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Technological Innovation Within Villas Miserias in Buenos Aires

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Abstract: *The main objective of the proposal is to modify and to improve the current social, economic and technological condition of the "villas miserias", the urban informal settlements in Buenos Aires, through the development of technological innovation processes. The principal strategies adopted are: the onsite production of raw material for building and construction, the development of building technologies using low and medium complexity processes to create new economic opportunities inside the formal construction market, the introduction of new building components to enhance the environmental sustainability and to improve the architectural quality of the existing "casillas".*

Technological innovation, slums, natural materials

Dwelling's constructionSection

In 1951 Martin Heidegger made a conference in Darmstadt where he raised the concept of "dwelling" as "the manner in which mortals are on the earth" and building "as the nature of dwelling". «[…]If dwelling is how the man defines himself in relation to the earth, the sky, the sacred and the mundane, house is the "shelter" of these relationships. To build the dwelling is to create space for shelter from the rain, to let in the sun, "to the altar corner behind the community table" and to provide all the places for life» (Heidegger, 1951).

Samuel Mockbee, the co-founder of the Rural Studio who dedicated his professional life to elevate the living standards of the rural poor, stated that: «Everyone, rich or poor, deserves a shelter for the soul» (Samuel Mockbee, 1996) and that architecture is a social art that has the responsibility to deliver both functional and spiritual comforts (Oppenheimer and Hursley, 2005).

The problem of the absolute degradation and neglect conditions, in which a large part of the world population pays, seems to be deeper and deeper. It is assumed that 30% of the world's population lives in slums, and that "poor of the twenty-first century are out of the modern production of wealth, but more importantly, marginalized from the resources of hope" (Fluvio Irace, 2008).

Considering the official rates from 2010, only in Buenos Aires city there are more than 200.000 persons who live in "villas miserias" (Argentinean slums), but unofficial sources give a number of 350,000 inhabitants. This problem is particularly acute in the rest of Argentina, where more than 25 percent of dwellings present housing deficit.

As in the case of other cities in the southern hemisphere, the growth of Buenos Aires is characterized by the densification of the urban center (inhabited by the middle and upper classes), and the expansion of the informal city, which is generally inhabited by immigrants

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who live on the margins of society. These last ones are marginalized from the processes of production and development, but provide the labor force for the creation of goods to which they have not access.

Considering that the great part of the able-bodied adults in urban ghettos work in the construction industry, the effort to increase work incentives in this sector and to create new economic opportunities through the study of unconventional building technologies, leads to encouraging conclusions about the endogenous growth of the slum. “Bidonvilles, from a certain point of view, are the laboratories of the future, in a world that slides into poverty "(Friedman, 2009). This study is based on some topics including economic and environmental sustainability, the attempt to obtain appropriate technologies through self-planning and self-construction, and possibly the independence in food production and water procurement.

The unconventional and sustainable production process within urban slums could modify the existing social, economic, and housing conditions. The availability of a large labor force in the "villas" would also allow experimentation and dissemination of the more successful techniques in other contexts and inside the formal construction market.

Appropriate technologies

Considering that the recent government policy tends to consolidate and urbanize the slums in their current location, the entire project is focused on developing appropriate new construction technologies within the “villas”, along with a “technology’s role review […] associated to resource’s contention, waste’s reduction, participation, control and process management by users, non-monetary factors evaluation, and attention to the man "(Bocco, Cavaglia 2008).

In order to reach this objective, attention must be paid to the green building materials available in the metropolitan or surrounding areas and to the more sustainable self-construction technologies, suitable to be developed in urban sites.

Exergy is a measure of the quality of energy and it can be consumed or destroyed through the operation of any physical or mechanical system. Exergy may be related to some environmental impacts and quantifies the sustainability of a process (Hau JL1, Bakshi BR. 2004). A great part of exergy could be destroyed during the life cycle of a building mainly during the production phase of materials and components and the construction phase (Koroneos, 2012).The whole project aims to reduce the use of most scarce exergetic resources encouraging improved process design and the introduction of new technologies.

In the present work local raw materials has been selected and new building component prototypes have been designed and self-built to improve the environmental sustainbility and the envelope quality of the existing “Casillas” (slum's houses). Densification and functional adaptation have been addressed through the planning of lightweight structures, separate from the existing ones. Higher insulation from the rainwater and the prevention from runoff and

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flooding have been solved adopting green roofs and creating new green productive areas. In addition to the technical requirements, this proposal took into account other issues related to the human needs, such as the social emancipation, the recognition of the individuality and the possibility to build up its own image.

Another objective of the work was to introduce new building components into the formal construction market, giving a new economic opportunity to the inhabitants of the slums.

Several surveys and site inspections have been carried out in two slums of Buenos Aires: Villa 15 y Villa 20. During which it was possible to identify materials and technologies used to build up traditional houses. Concrete and fired clay bricks resulted to be the principal construction materials. The most diffuse structural module shows dimensions ranging from 2.5x2.5x2.6 to 3x3x2.6 m, and an almost total absence of thermal insulation and waterproofing, as well as wall masonry coating materials. There is also an evident structural risk in the case of houses built up without any kind of prior structural analysis or soil verification, and subjected to increased loads due to vertical densification.

Plant Bases Materials: Bamboo and Hemp

Plant based materials, especially bamboo and hemp, are renewable resource which store carbon through photosynthesis during their growth and produce oxygen. Cultivation of these plants could take place in suburban and urban area, where there are large industrial infrastructures now disabled, and reduce the environmental impact of building industry. Pollution of the town could be limited and the control of rainwater runoff may be enhanced, improving the quality of the urban environment.

Different sites inside the metropolitan area of Buenos Aires are suitable to create productive parks in relation to the time of harvest, production and processing of raw materials. They can be designed also for a recreational function and provided with access control. These areas are in the neighborhood of the urban slums: there are more than 800 hectares within the city, and more than 8.600 in the metropolitan area. Furthermore the Delta of Paraná river is a particular case of production of forest area and processing material located at less than 25 km from the center of the city.

The exceptional geographic and weather conditions of Buenos Aires region, make it possible the cultivation of various species of bamboo. Nowadays in the Delta of Paraná river there is a large number of indigenous and imported species of bamboo. Clara Peña, a landscaper working at the Dirección General de Islas, verified that local bamboo could be an economic resource for local people. She developed technological transfer projects for cultivation, post-harvest treatment, and material processing (Peña, 2013).

Bamboo species which grow within the Delta could be cultivated also in the continent. Bamboo cultivation could be a sustainable alternative against deforestation because of its characteristics of cultivation: the possibility of a constant exploitation, the annual harvest of mature canes useful for forest subsistence, the rhizomes strengthening and the consequent

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growth of more robust canes. Figure 1 indicates possible species to be grown in Buenos Aires and the conditions and possibilities of exploitation (Rugolo 2013, Minke 2012).

The potential of bamboo as local natural material in housing has been tested during the workshop: "Construir con el Delta" (coordinated by Clara Peña -DPDI-, and Emiliano Cruz Michelena Valcárcel - Politecnico di Torino). A prototype of social housing was built using the structural module of the "casillas" and new technological solutions were experimented, such as standardized raw earth elements, green roofs and hydroponics.

The species of bamboo used in the project, which are also the most widespread in the area and the most suitable species to be cultivated in urban environment, are: Arundinaria Japonica, Phyllostachys Aurea (commonly known as tacuara) and Viridis Philostachys Bambusoide. They have been mechanically tested: Ph. Aurea reached 44 MPa in compression and 183 MPa in traction, while Ph. Viridis reached 38 MPa in compression and 166 MPa in traction.

Another bamboo type considered for cultivation is the Guadua Chacoensis, whose adaptation potential to the region is still under study but that counts some successful experimentation in Buenos Aires province. It is a native species from northern Argentina, having considerable dimensions and exceptional qualities for construction.

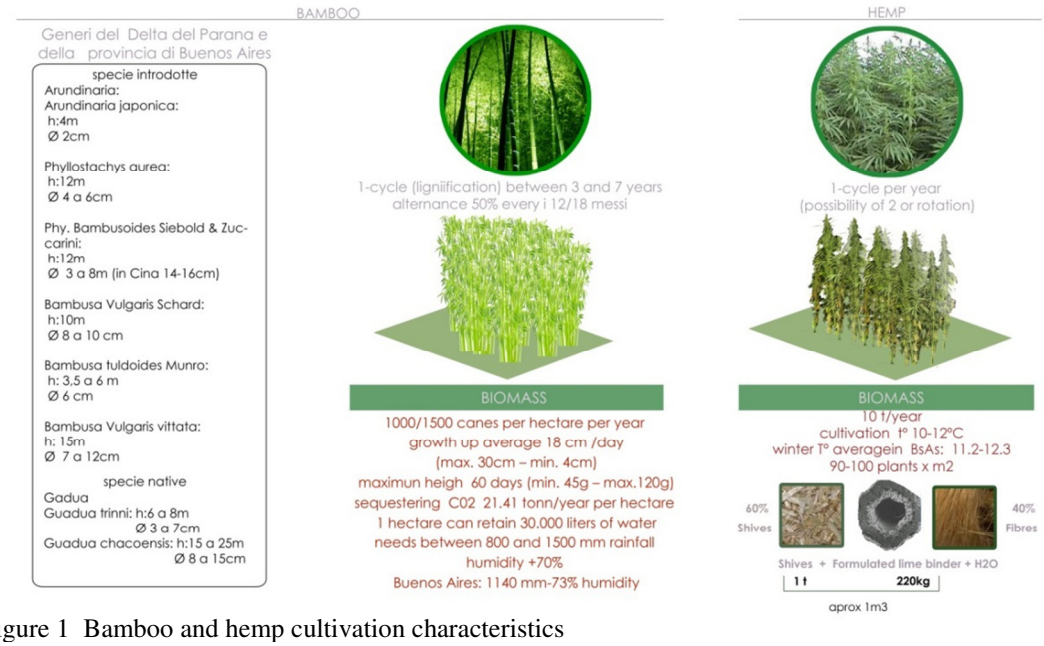

Figure 1 Bamboo and hemp cultivation characteristics

A green roof over bamboo prototype structure has been realized with a weight ranging from 45 kg/m^2 (dry) to 75kg/m^2 (wet), and a maximum bearing capacity of 1200 kg. The waterproofing has been realized using silos bag, waste of industrial production, and discarded plastic urban posters. This kind of roof could partially solve the problem of infiltration of rainwater in housing without a proper cover.

Basing on some technological solutions created by Yona Friedman , bamboo structures, obtained combining different species, are proposed for densification of the slum applying very low additional loads over the existing concrete structures.

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Hydroponic agriculture panels were also built, which control the solar radiation and improve the quality of façades. They provide also a partial solution to food procurement. During the workshop "Construir con el Delta" a prototype of brise soleil was built using bamboo canes (figure 2) as containers for different kind of cultivation. Vertical cultivation cladding panels were also experienced during Pro-Rom workshop (Politecnico di Torino, Italy), using pallets and other recycled materials and components. During this last project, bamboo was used to make panels for internal and external claddings coated with earth render. Hydroponic framing panels and bamboo cladding panels can be easily included into the formal building market due to the quality of design and the possibility of standardization.

Hemp cultivation and elaboration

Hemp cultivation is particularly complex because of the Argentinian drug control legislation (Law Number 23,737) forbids cultivation of Cannabis Sativa. Until the seventies of the past century, there was a big company in Buenos Aires, Linera Bonaerense, dedicated mainly to the production of flax and hemp, which developed one of the largest industrial complex in the country. The University of Buenos Aires has recently made a formal request to allow the entry of the hemp seeds inside the University campus for carrying out crop tests. The characteristics of growth, especially during winter period, will be studied in order to insert hemp as a rotation crop. Some characteristics of cultivation are reported in figure 1.

A hemp based lightweight bio-composite building material may be elaborated combining hemp shiv, a renewable plant aggregate, and a lime based binder. Hemp-lime is a non-structural material used for walls, roofs and under-floor insulation. In the present work a hemp-lime composite coupled with a bamboo structural frame has been developed to improve the thermal properties of the slum's houses, as suggested by Peter Walker: «Hemp-lime has modest structural proprieties, but it could enhance compressive timber/bamboo framework's load capacity, could reach higher levels of insulations and like many other natural materials it is hygroscopic, which enhances its heat storage capacity" (Walker, 2013).

Worldwide several companies have successfully begun to market hemp products and the chances of entering hemp building elements into the formal market have already been tested, for new constructions or existing buildings restoration.

Raw earth elements

Different elements made of raw earth could be combined with the hemp-lime to improve the thermal performances of the envelopes. Two kinds of prefabricated systems could be easily introduced into the formal market and even in the urban areas. During the project Pro-Rom (Giura, 2013) compressed earth blocks (5 cm thick) with different textures have been placed into metallic frames to create internal or external cladding panels. During the workshop "Construir con el Delta" a re-elaboration of the Peruvian quincha has been experimented using local canes and standardizing the internal panels characteristics.

Several samples of sediments coming from different sites located in the Delta of Paraná river and the Rio de la Plata were tested during the workshop and their characteristics were

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determined to verify the possibility to use these earths as construction materials. More than 160.000.000 tones/year of sediments are transported by the Parana and Uruguay rivers and arrive to the Rio de la Plata. The water flow causes the collapse of the banks and the transport over large distances of debris. The deposition of sediments which takes place in the Delta area produces a land growth of 50-90 meters/year towards the center of Buenos Aires.

Earth from Delta has been used to build houses, until the thirties of the last century after which its use was almost completely abandoned, being replaced by new technology and industrial materials. Sediments accumulated in the bed of the Rio de la Plata in Buenos Aires must be dredged and, contrary to what the law requires, they are thrown to the coasts enlarging the continental area. These sediments may be used for the elaboration of stabilized earth products which could be part of the commercial circuit of materials and building components.

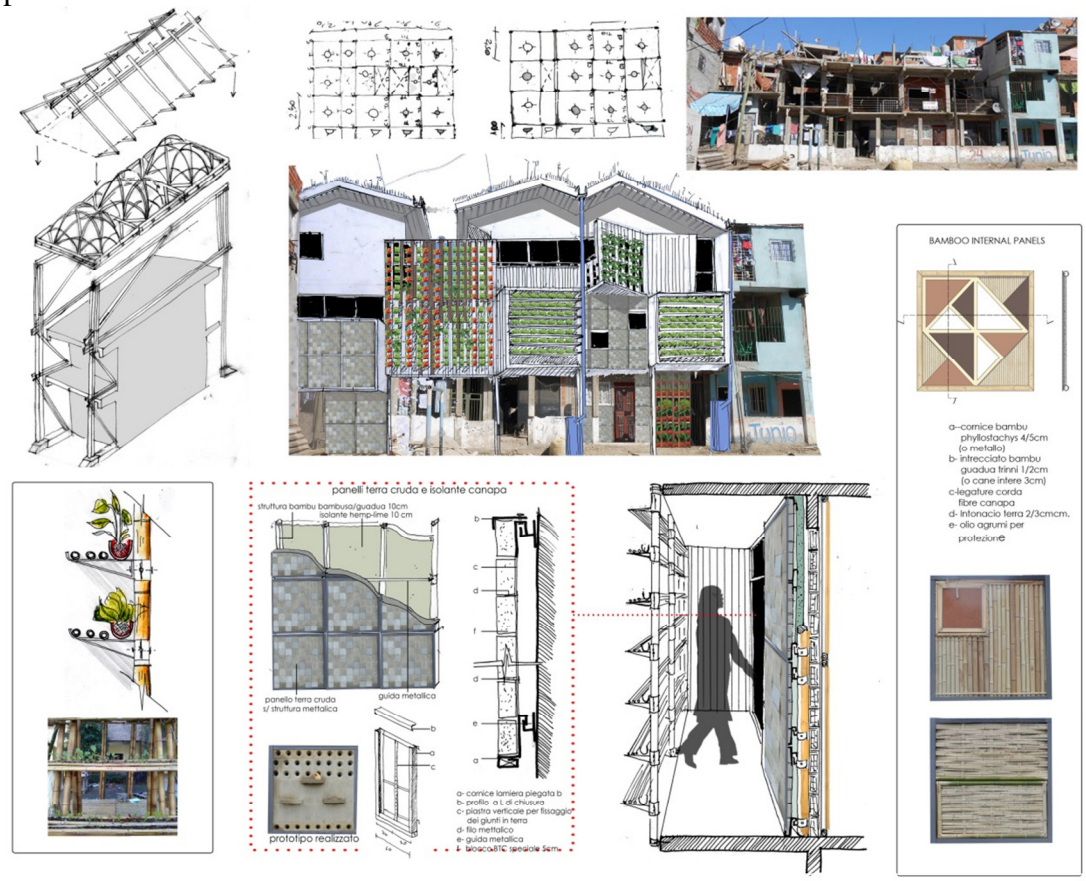

Figure 2: Current state of "Casillas" (slum's houses) and low-cost enhancing project with natural materials

Technological transfer and diffusion

The diffusion among professionals and users of the economic, technological and environmental benefits of these materials and components is necessary to ensure the success of the project. During the workshop "Construir con el Delta" the communication system and the technological transfer have been experimented by the elaboration of self-construction manuals which simplified the comprehension for unskilled labor force (figure 3). At the same time a documentary movie was made on the construction process and different activities and workshops were carried out in professional institutions and universities.

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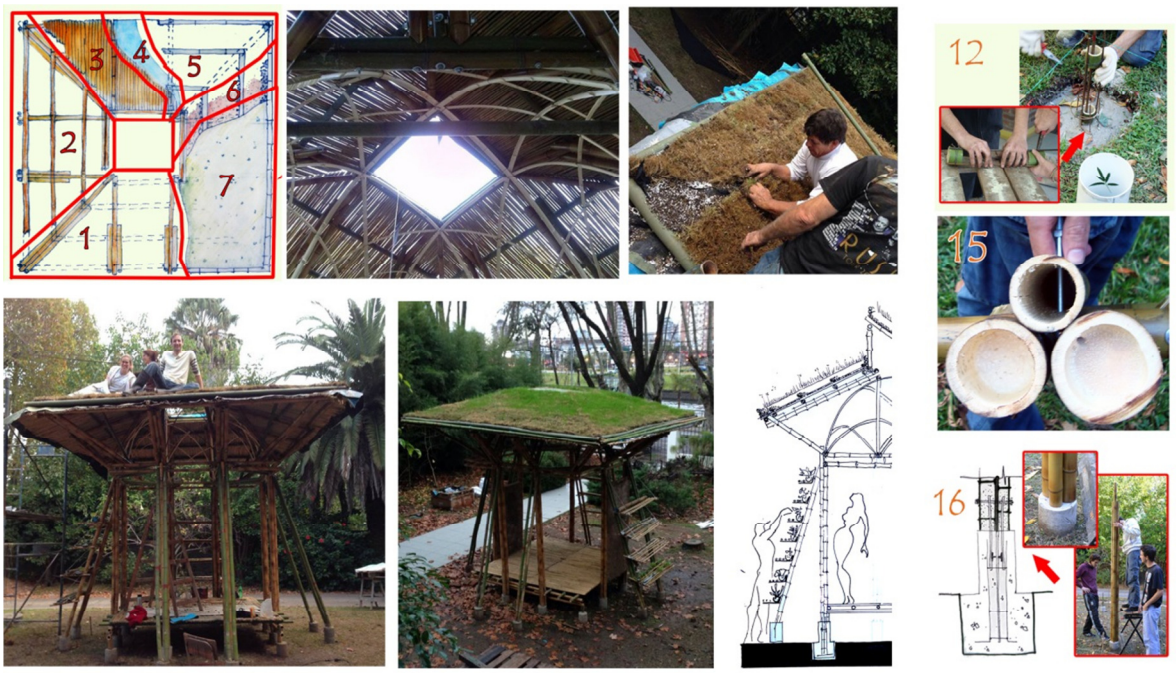

Figure 3 The project “Construir con el Delta”: prototype and self-construction manual.

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