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Housing and health: a local and tailor-made low-tech approach to minimize diseases in a rising community of Haiti

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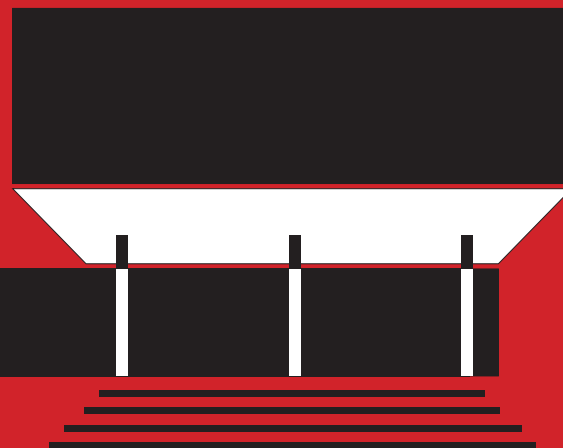
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## Conference Importance of Place - Conference Proceedings (CD-ROM)

5th International Conference  
on Hazards and Modern Heritage



I M P O R T A N C E O F P L A C E

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# ABOUT

Conference is organized as Pre-Congress activity of 2nd Biennial of Architectural and Urban Spaces, BRAU2, 15 - 30 October 2013, under patronage of UNESCO.

Conference as a main goal has to introduce modern approaches for the preservation and management of cultural heritage and introduce Young People to the Protection of Heritage Sites and Historic Cities. Actions that contains management plan, with long-term goals, may include active and passive use, in order to achieve the sustainability of heritage and involvement in modern trends of life and to satisfy main demands regarding aesthetic values, comfort of living areas and environmental sustainability.

It is also an opportunity to coordinate, promote and encourage the exchange of information for a historical cultural heritage, and define mechanisms for the protection of modern architectural heritage.

We must add the sense of the relation between memory, territory and the quality of a meaningful life which underlies the associative heritage work in considering the importance of place; we highlight the concepts of community resilience and risk management, key aspects of a response to change, while we define the word “sustainability”, the responsibility of us living people towards the heritage we received and towards the heritage we will leave to our successors, in order to play a pivotal role.

All this leads us to a conclusion that there is a need for a new responsible architectural ethical design that will surpass the ego, the pretentious and abstract architectural concepts, but will result in a “dynamic process” through design and buildings life cycle.

The best way to preserve a historically valuable modern building is if one you can make the house owner be aware of the values of the building, see to that he gets the needed knowledge how to maintain the building and that he is proud of being the owner. It is also important that the building is used and that it is used in a way that respects the historical values of the building.

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## HOUSING AND HEALTH: A LOCAL AND TAILOR-MADE LOW-TECH APPROACH TO MINIMIZE DISEASES IN A RISING COMMUNITY OF HAITI

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### **ABSTRACT**

With the slogan “Intelligently designed housing can dramatically improve people’s health”, the non-profit U.S. association Arch.H.I.Ve invited applications in 2010 for the implementation of five low-cost housing prototypes for families affected by AIDS and tuberculosis in Saint-Marc (Haiti). This was the opportunity for an Italian team of three architects, one doctor and one engineer, to submit a project inspired by construction methodologies able to harmonise elements of bioclimatic architecture with the psychophysical needs of the future occupants.

‘Shutter Dwelling’ was short-listed as one of the five winning projects, and its implementation is currently underway. It was inspired by a holistic approach to housing design which looks at a building as a whole generated by the interaction of three types of factors: energetic factors (air, sun and water), which guarantee the microclimatic suitability of indoor environments; viral factors, which prevent the spread of infections to other family members; functional factors, which facilitate the interaction of patients with the other occupants and the wider community.

Taking its cue from that project, this paper seeks to contribute a new conception of housing design, suitable for ‘temporary’ dwellings. The approach it proposes takes into account traditional elements such as construction time, costs and reproducibility, but also caters for healthy, habitable environments, which preserve the social interactions of the occupants and are respectful of the local culture.

*Keywords: natural disasters, housing, health, infectious diseases, temporary dwelling, habitable environments, local culture, passive cooling strategies.*

## 1 INTRODUCTION

The theme regarding rebuilding in areas affected by environmental disasters, presents a fundamental issue: to manage the emergency of keeping intact the connection between the territory and its own cultural inheritance, as well as fixing the socio-economic rifts that are inevitably created. International help, therefore, cannot be limited to immediate help, intervention response, fast reconstructions or economizing in the materials cost-effective means. There's a strong need to start rebuilding processes that focus on the environmental wellbeing, the management of social imbalances as a central topic in reconstruction, and that pay close attention to social and cultural aspects that for centuries have been regulating the relationship between locals and their own territory.

The project henceforth introduced, is the result of a series of considerations over these themes, that took place after a planning competition for the island of Haiti, where the 2010 earthquake caused thousands of casualties and has left an impoverished population. It was sponsored by the no-profit American organization "Arch.H.I.Ve", that for several years has been addressing the issue of the relationship between health and architecture.

The competition application, *Kay e Sante non Ayiti*, "Housing and health in Haiti" was going beyond the simple planning of provisional houses for the displaced people it was required to plan housing prototypes for AIDS and Tuberculosis (TB) patients which, in the long run, would be part of a new settlement that would allow sanitary assistance to such patients, in order to reinsert them into the social fabric - once they have come out of the critical stage of the illness.

Such application had two main considerations:

Haiti has the highest Tuberculosis (TB) infection rate in the Americas. After the earthquake, the risk of disease increased as many TB patients saw their care and treatment interrupted. Residents displaced from the quake-stricken capital Port-au-Prince fled to Saint-Marc, causing overcrowding and placing severe strains on the city's infrastructure.

At same time, In Haiti, people living with HIV/AIDS continue to be the victims of severe stigma and discrimination. They are rejected by society and even by their own families. Many of them become homeless. This makes them even more vulnerable to infectious diseases such as Tuberculosis.

Dealing with this situation meant to start with "the last among the last" and therefore to place into the planning of the project particular sensitivity and respect when making personal decisions, as well as imagining, while planning, of taking its future inhabitants by the hand as if with one's own sick child. Therefore, more attention was paid to the ventilation issues, in order to avoid exposure to tidal waves during windy days or to provide specific areas in the house that would allow to enjoy healthy sun exposure during sunny days. Specific common areas where proposed) so that the patient could spend much of the day with the other inhabitants, without



feeling lonely, always giving him a perspective of life. This is the approach in which the project was developed, thanks also to the cooperation of an immunologist medic and an engineer - an expert calculator of energetic requirements.

## 2 SPECIFICS OF THE PROJECT

The prototype was to be built in an uninhabited area about six kilometers from St. Marc, that was to be used to host a newly planned neighborhood for families with AIDS or Tuberculosis patients. This settlement was also to be used as a model for future constructions of new neighborhoods in the overcrowded suburbs of St. Marc. The new establishment, other than houses, would have a hospital, an orphanage, a reception center and a community center. The neighborhood had to represent a kind of community for families with TB and AIDS patients, that would also facilitate assistance to such patients for a period of time of about two years, during the critical phase of the illness. Afterwards, it would facilitate their return to the social fabric, making space for new patients.

The call for bids required the planning of one house for 3 to 4 people with at least 1 patient. It had to be of about 100 square meters with 3 bedrooms, 2 bathrooms, one kitchen, a common area and an open area.

Based on climate figures regarding the area (Tab. 1), a project strategy was laid out, which was suitable for the context and was also careful to take advantage of the available resources. We are talking about a typical tropical-hot climate, with temperatures around 25 °C that are moderately stable throughout the year. The seasonal variations are dominated by precipitation, a rainy season from May to October and a pronounced dry season from November to March. It was therefore necessary to protect the building from strong exposure to the sun during the dry season and from heavy rains during the humid one. The local sun chart was very useful to us to set up the exposure of the house to solar radiation, in order to protect it, but also to guarantee the possibility to take advantage of the positive energy that the sun has on Tuberculosis patients, in specific rooms of the house at certain hours of the day.

Table 1: Sant-Marc, Haiti - Solar energy and surface meteorology

Variable	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Insolation, kWh/m/day	4.32	5.09	5.86	6.22	6.27	6.82	6.74	6.41	5.90	5.14	4.43	4.15
Temperature, °C	24.5	24.9	25.4	25.7	26.1	26.3	26.1	26.2	26.1	25.9	25.4	24.8
Wind speed, m/s	6.85	6.78	6.56	5.62	5.78	5.97	6.87	6.35	5.60	5.14	6.56	6.92
Main wind direction	W	W	W	W	N,W	N,W	N,W	N,W	N,W	N,W	W	W
Precipitation, mm	4	12	18	48	127	138	120	129	139	126	29	1
Wet days, d	9.6	7.7	8.0	8.4	11.4	11.0	13.2	13.3	14.4	15.7	11.5	10.2

Another important aspect that was noted, was the direction and strength of the main winds, which was of fundamental importance to adopt passive cooling techniques and to control the flow of pathogenic agents. It was also necessary to deal with the extreme vulnerability of the area to earthquakes and hurricanes.

### 3 THE AIM OF THE PROJECT

One of the aims of this project was to find a functional organization of the space that included as key points:

- The independence of the bedrooms and the connected restrooms from the other areas, in order to avoid the mixture of infected air flow from the bedrooms with clean flows from common spaces, thus minimizing the risks of infection;
- Direct access for each room to common spaces, to minimize the usage of hallways and transit spaces;
- The kitchen as a semi-opened room, that was both consistent with the local cultural habits and easy to be cleaned from toxic fumes.
- To achieve the best possible level of wellbeing of the environment by taking advantage of passive cooling techniques, as the crossed ventilation, the micro-ventilation of the roof and the management of sun radiation of the walls.

The functional distribution of the space mainly had to facilitate the interaction of the patients with the other inhabitants, the environment and the micro climate of the house, according to their health status.

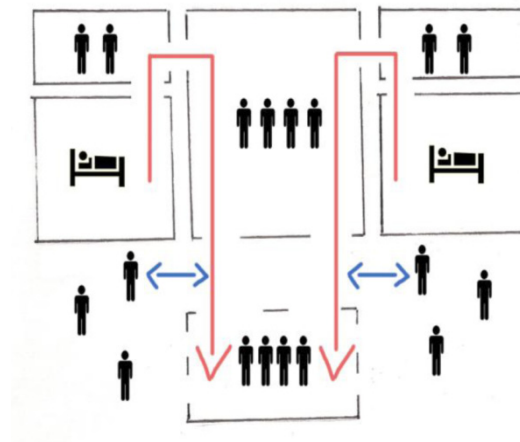


Figure 1: *Occupants circulation scheme*

The patients had to be allowed to move inside of the house, gradually moving from a closed and separated setting in the bedroom to another setting that was extremely open and interactive, like the kitchen, that according to local cultural traditions, represents the specific area in the house to meet and socialize with the other residents and with the surrounding natural environment.

#### 4 INFLUENCE OF HEALTH

Since we had to design a house dedicated to Tuberculosis and/or HIV-positive patients, we started by planning the bedrooms. In normal conditions, the bedroom represents a place mostly used during night hours to rest, while in this case it becomes a pivotal space where the patients can spend most of their time.

As we had a space of approximately 16 square meters, we thought about a flexible solution that allowed us to reorganize the space, moving from a cozy and protected environment to a permeable one, more exposed to the outdoor - a sort of loggia. A sliding panel allows the separation of the two areas, or to merge them into a single one, depending on the needs. This way, the loggia works as a filter that allows to modulate the transmission of heat to the inner room, thus reducing its accumulation and regulating crossed ventilation. Crossed ventilation also prevents the accumulation of moisture and cools down the temperature of the inner environment, if needed.

By opening the wooden splinted panels, it is possible to control the sunlight coming into the room. It has been proven that sunlight is effective in killing the Mycobacterium of Tuberculosis, the pathogen responsible for Tuberculosis. [1]

This feature, together with a high natural ventilation, reduces the risk of dissemination of the Mycobacterium of Tuberculosis contained in dispersed droplets. [2]

This is one of the reasons why specific attention was given to ensure the natural ventilation of the room. The ventilated wooden roof system facilitates the airflow towards the outside without contaminating the common areas. Thus bedrooms become an autonomous and healthy environment.

In a family with one or more patients it was necessary to separate them from the other occupants. We planned two independent bedrooms cores, connected through a common space; each core with its own restroom. This way, access to a healthy restroom is always guaranteed. A wind hallway in the living room, open towards the North-South direction, facilitates the removal of pathogens, thus contributing in keeping the domestic environment healthy.

This air flow moves toward the kitchen. The continuous ventilation helps to avoid the accumulation of toxic fumes in this area that is indeed separated from the remaining areas of the house.

In the whole apartment the crossed ventilation obtained by searching and conveying the main winds helps to clean all the spaces through the continuous change of the air. [3]

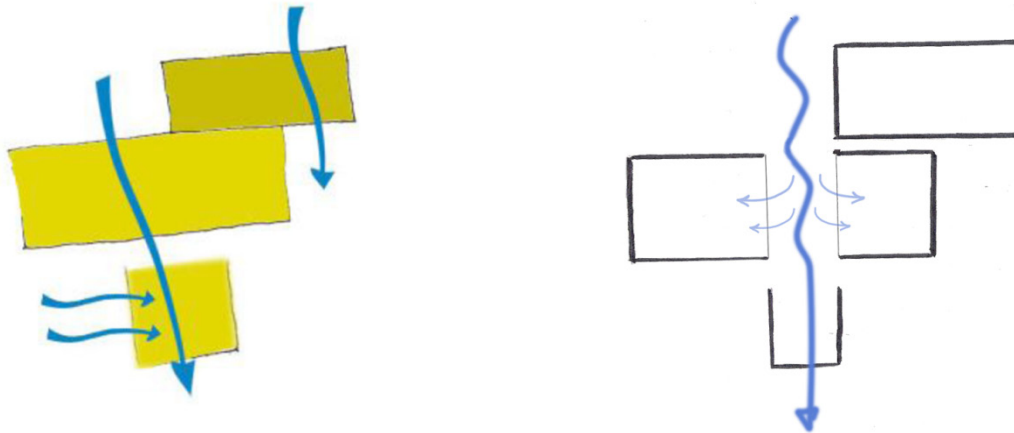


Figure 2: (Right) Air flux through the house due to dominant winds; (Left) Ventilated hallway system

## 5 OVERALL DESIGN DESCRIPTIVE

The whole project is composed of two main contiguous volumes, combined in order to take advantage of the local climate. We decided to develop the whole building on a single floor in order to reduce the sun radiation on the two sides, since we also had to minimize the overhang of the roofs due to the frequent hurricanes. [4]

The expansion of the building on the main East-West axis ensures the maximal exposure to the North and to the South, where the sun radiation is easily controlled. This allows us to use in the best way the dominant summer winds coming from the North, with the purpose of a crossed ventilation in every space. [5]

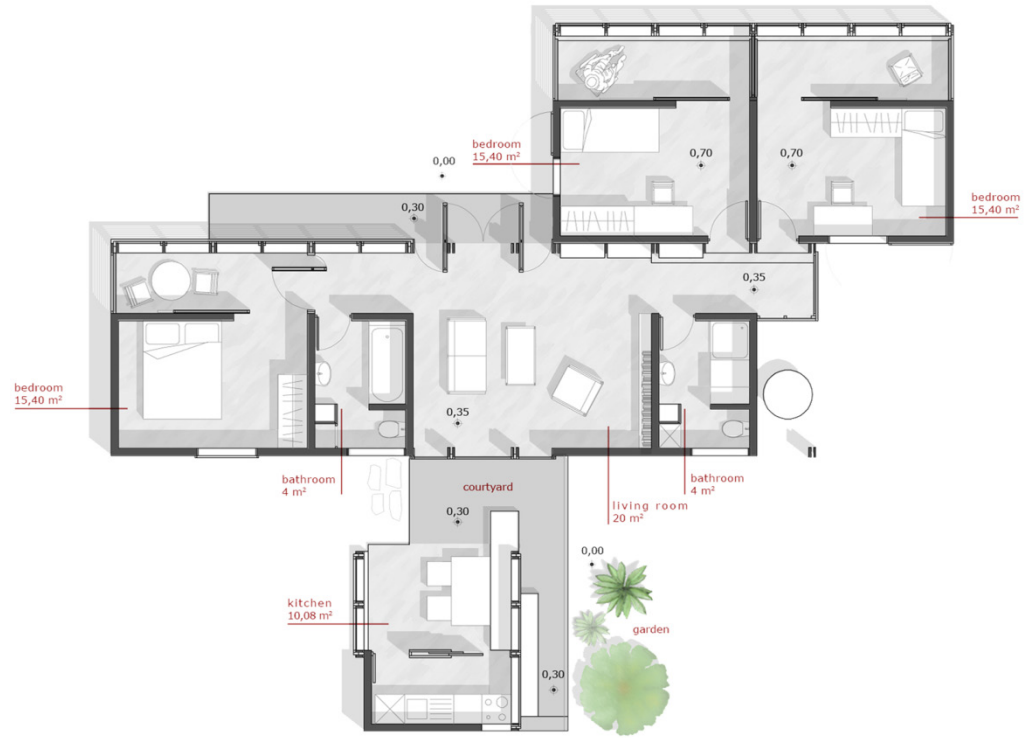


Figure 3: *Project plan*

In its development, the whole project rotates on the idea of space flexibility. The single environments can be used as closed and protected or as open, thanks to the use of permeable and movable components. As for the bedrooms, even the common areas, living room, kitchen and courtyard allows a more flexible management of space, opening out to interact with each other as a single large space, or closing it to separate each function.

The courtyard is the link between the living room and the kitchen. Normally this is the most intensely lived and important area for these people; due to the flexibility of the project, the courtyard moves according to the needs of the inhabitants.

In order to satisfy the cultural needs of people used mostly to live outdoors - even to cook and eat - we planned the kitchen as a covered room, but at the same time with an opening towards the external area. It can be only partially closed to allow good savings; also in this case,

sliding panels are used; so that when open, cooking outside is also possible. A piece of furniture that helps having a better management of the space: a permanent bench located across the border of the kitchen and the courtyard that allows to move the table from the outside to the inside, according to the season.

The kitchen is an area that is separated from the rest of the house and connected to it through the courtyard. Its particular location allows to prevent the spread of toxic fumes and smells in the rest of the house, taking advantage of the prevailing winds from the west during the winter and from the north during the summer.

The living room, the common space that links the other spaces of the house together, can be opened towards the courtyard and the kitchen, generating therefore a bigger and more complex space to socialize. This can be achieved by opening and turning the movable panels that normally represent its external border.

By keeping open panels on the North and South side, a wind hallway is created to help ventilating the kitchen located at the end of the flow. The hallway also facilitates the ventilation and the change of air of the whole house, and allows to cool down the living room and the surrounding areas. [6]

## 6 THE STRUCTURAL PROPOSAL

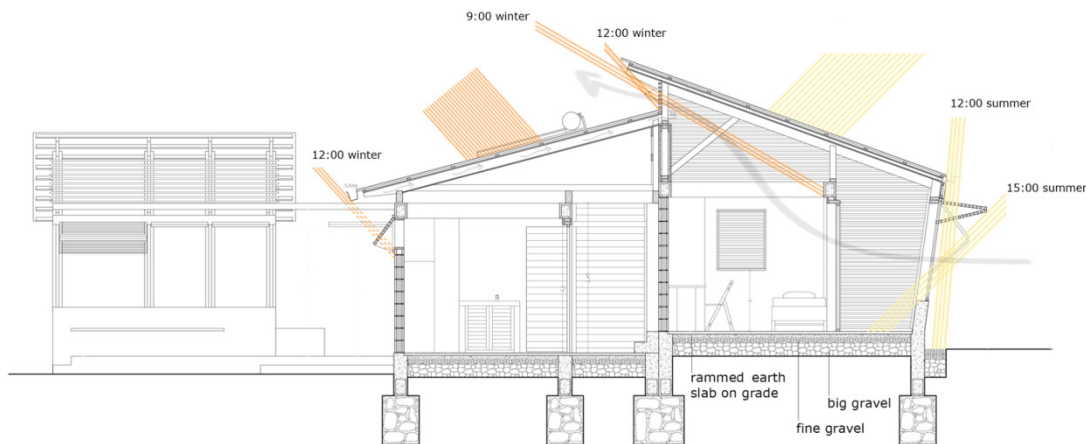


Figure 4: *Section bb' with solar screening and ventilation strategy*

The choice of construction techniques was based on two main factors:

- availability of materials in site.
- feasibility of construction with non-skilled workforce, mostly using local techniques of construction.

The structure was planned as a series of solid rectangular blocks of concrete where another wooden lighter structure, also defining the covers, is held on and rolled up. In this way, the concrete structure beats the rhythm of the house environments and of the roof structure.

The concrete bodies have a framed closed structure of reinforced concrete columns and collar beams; the CMU walls reinforced with vertical and horizontal rebars contribute to further strengthen the structure, improving its seismic resistance. [7]

As in the bedrooms, the elastic wooden structure allows to obtain a more flexible and air-permeable wall and in the meantime represents a solution for the light of the covering. Two different facing structures cover the block of two bedrooms and the long block including the living room, the other bedroom, and the restrooms.

In the covering structure of the core at North-East, the wooden beams hang on pairs of pillars that lean on the concrete structure; the pair of pillars allow to embrace the beam, thus facilitating the connection through bolts. On the North side, the angle of the pillars allows a major shelter from the rain. The North wall is made of tiled wooden panels, that can be individually opened. The system to open the shutters has been extensively used in the project, for the North wall, for the South entering doors and for the permeable kitchen walls exposed to the East. To open the panels of the living room on the North wall we chose a revolving system on a steel central pivot.

Openable doors and windows are designed so that they always lean on the structure in stone or wood and not only on the shutters, finally in order to improve resistance to hurricanes. [4]

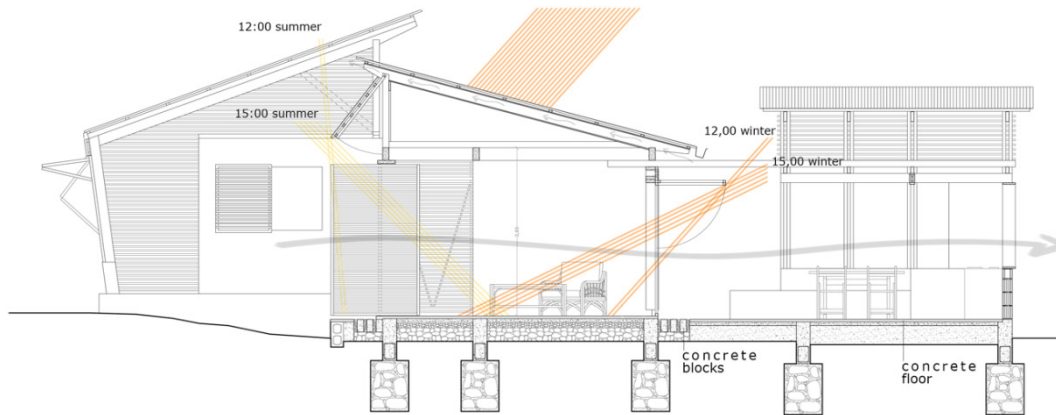


Figure 5: *Section aa' with solar screening and ventilation strategy*

## 6.1 Covering structures

For the covering, we planned a system of a ventilated roof in order to create an air blade between two layers of “plywood” below the covering metal sheets. Due to the overheating of the plate, the air will move towards the outdoor also pushed by the dominant winds; a continuous change of air will be obtained inside the blade that will reduce the transmission of the heat to underlying spaces. [8]

On the opposite block, the structure of the roof will have a movable counter pitch that will further save the wall from the rain and that can be closed in case of hurricanes in order to remove surfaces that can become dangerous due to the strong winds. For the same reason, the overhang of the roofs are not bigger than 50 cm. [4]

The covering of the porch is made of wooden tiles that can be oriented in order to protect from rain or sunlight, if they are completely closed or open, respectively.

Moreover, the structure of the tiles will make a horizontal grill that will reduce the strength of the wind in case of hurricanes.





Figure 6: *Rendering image, view from south-east*



Figure 7: *Rendering image, view from north-west*

## 7 TECHNICAL IMPROVEMENTS

### 7.1 Thermal Solar Panels

The orientation of the house and the data concerning local climate and sun radiation suggest that the sun is a good resource for energetic purposes.

The covers were planned and made to allow the installation of a solar collector with a capacity and reservoir for 60/80 liters of water. The cover is exposed to the South with a slope of 18 degrees; this choice represents a compromise between the structural necessity to ensure the stability of the pitches and at the same time to arrange the installation of the collectors. The cover will be of easy access either for the maintenance or the cleaning of the collectors, as well as for the use of the SODIS technique to obtain drinkable water.

The storing reservoir of 60/80 liters is enough to satisfy the needs of a family of 4 people without affecting the capacity of water for sanitary uses, both allowing temperatures between 35 and 40 degrees Celsius and an optimal integration even during the rainy season.

### 7.2 Water supply

The main pitch of the roof cover, works as a surface to collect rainwater and to conduct it to a filtered tank. The reservoir is planned to achieve a capacity of 150 liters and will guarantee a volume of water adequate for several weeks, even during the months when rain diminishes greatly. The tank will be provided with a filtered system made of several layers of rocks, and a colloidal silver-enhanced ceramic water purifier (CWP). Field experience and clinical test results have shown that this filter effectively eliminates approximately 99.88% of most water born disease agents. At the end of the filter process, the tank will release drinkable water.

## 8 CONCLUSIONS

The project won a third place among the five winners of the competition, and it's currently underway. "The judges were particular impressed by the extent to which this design blends with Haitian culture and landscape". This was the main reason for which the jury allocated the prize as well as the proved efficiency of our research regarding the socio cultural aspects of the area that, together with the in-depth analyses in the technological and medical fields, has accompanied the whole planning phase.

The strength of this project can be therefore found precisely in the effort to consider architecture as an enclosure, molded according to the needs of the inhabitants and taking into consideration the environmental and cultural aspects in which they live. The attention paid to

the natural and climatic elements, the socio-cultural dynamics and the viral approaches defines the constraints on which the project is built. A design approach that enriches the theme of building houses in “weak” environments, of new elements of research that emphasize issues of health, both physical and physiological of the inhabitants, offering, among other things, technological solutions that can be reused in tropical areas as well as a functional articulation that can be easily adapted to different needs. According to that, it’s important to notice that at the end of the competition, when the moment came to develop the detailed design, Arch.H.I.Ve asked us to review the whole project. Due to a sudden reduction of the initial budget, we had to remove one bedroom and one bathroom. It was easy for us to put together again the pieces of our original idea on a smaller surface without changing the fundamental guidelines that had led us to the original project.

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