Improving Comfort in Microbrigada Buildings in Cuba

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Abstract:

This project has as main goal to have a real impact on the lives of "normal" Cubans. The specific objective is to improve comfort in Microbrigada buildings because is a typology which is spread all over the country and home of thousands of Cuban families. The common problems in these neighborhoods are overcrowding, overheating, lack of privacy and unused public spaces. To tackle these issues, two strategies were tested not only from the environmental point of view, but also according to social impact and economic feasibility.
One of the envisioned schemes proposes a large-scale intervention in which roofs will be shaded and atriums will be created for improved natural ventilation and daylight. The other strategy has a different approach, it looks to create an economic and easy to build and install system that can be adapted to the diverse needs of solar protection, visual privacy and noise control of the inhabitants. The device will change according to the user's needs and it will be attached to the windows. The outcome was a design which provides comfortable and nicer spaces for their users, and is affordable to build and apply in all Cuba.

Introduction

Housing in Cuba is in a dare situation. Until just a few years the sale of dwellings was prohibited in the country. People must live in either inherited or government-assigned dwellings. Today, even when it is legally possible to buy or rent a house, most of Cubans cannot afford it. That is the reason why usually several generations of a family live together in a home. New homes are needed desperately, however there is not time and money for that. Retrofitting and adapting the existing buildings is a more realistic strategy.

Microbrigada buildings

The housing crisis is not a new thing in Cuba, in the 1970s the government put a in practice a strategy to try to solve the problem. The idea was to give the people the means and materials to build their own homes. The people would be organized according to their place of work in groups called "microbrigada" to build semi-prefabricated buildings. The chosen persons were allowed to work full time in the construction, but they received their whole salary. The layout of all buildings were the same, regardless orientation and location. There were built complete neighbourhoods in the outskirts of cities and in the middle of the countryside; also, if there were empty plots in the centre of the cities in which the layout could fit, they would be used as well. In ten years more than 100 000 homes were built.

Figure 1: Examples of Microbrigada neighbourhoods in Cuba

Years after the construction of the buildings its criticism has grown. Many people complain about how similar all buildings look like and how difficult it is to orient you in a neighbourhood of these structures. Most of the people catalogue the buildings as the ugliest in Cuba and the fact that the outdoor areas were not designed have made their image dreadful. On the other hand, even though each apartment counts with the basic rooms and installations needed to live properly, the interior spaces are most of the time uncomfortable.
Since these building were built there has not been a major investment to build housing as the Microbrigada movement in the 1970s; therefore, the housing situation has not improved. The families, that were lucky to get a home before, have been growing and usually more than two generations are forced to live under the same roof.
The idea with this project is to propose solutions for the main problems of the people who live in those buildings.

The impact that a proposal for Microbrigada buildings will have in Cuba is huge, because this typology is spread all over the country. The main structure of the buildings is made of concrete, walls were built with concrete blocks and the slabs were prefabricated. Originally, the windows were movable louvers of wood. All buildings have 5 levels with staircases distributed equally for 10 apartments.

Figure 2: A normal day in a "Microbrigada" building

The structure followed for this work was first to identify the main problems in the structures, then to set strategies to tackle the problems. As the next step, it was necessary to evaluate the strategies, using Transsolar tools like TRNSYS for dynamic thermal simulation and assessing the feasibility and social impact of each proposed action. As final stage, the final proposal was finished.

Figure 3: Structure of the project

To make the study more grounded it was decided to have as case of study a group of buildings located in Havana.

Figure 4: Case study

Problems Identification

In order to have an idea of the environmental problems, it was studied the climate of Havana. Cuba is a tropical country with temperatures throughout the year between 20°C and 35°C. The humidity is very high due to the closeness to the sea, more than 80% of the year the absolute humidity is above 11g/kg. The sun angle is quite high, being the horizontal surfaces as roofs the main places to protect from solar radiation. These characteristics of the Cuban climate provoke that the main cause of discomfort in indoor spaces is the overheating; however, natural ventilation and solar protection are good passive strategies to achieve comfort.

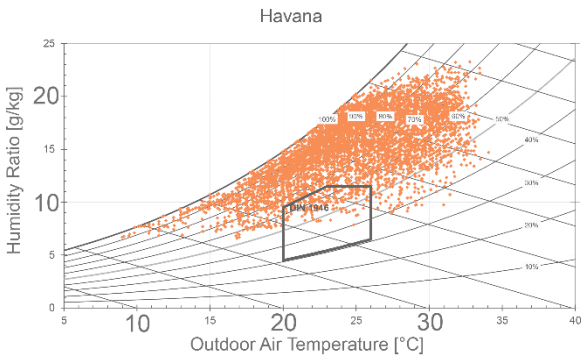


Figure 5: Psychrometric chart (Transsolar)

The environmental and comfort problems in Microbrigada buildings are closely related to the social circumstances. Overheating is caused not only for the lack of solar protection or the all concrete structure, but also for the overcrowding in the apartments and the fact

that the people do not want to open their windows due to the noise and the lack of visual privacy. Nowadays, the inhabitants must choose between having natural ventilation or quietness inside their homes.
To have an idea of the frequency and deepness of the environmental problems it was used thermal dynamic simulations to evaluate base cases. The objectives were to identify the percentage of hours of discomfort during the entire year in the current conditions in normal apartments. The chosen apartment type was one with two bedrooms, occupied by a family of three.
It was also decided to have three different base cases with the different windows that are present in this type of urbanization, because they have a significant impact on natural ventilation and solar protection. The first base case was with glass windows closed (no natural ventilation), the second case was also glass windows but natural ventilation during the time in which the apartment is occupied. And the last base case takes as windows the original wooden louvers that allows for natural ventilation and solar protection.

Figure 6: The base-cases

It was used TRNSYS software to simulate all three cases for a year. It was used as unit of comparison the Predicted Mean Vote (PMV), which classified as comfortable the values between -0.5 and 0.5. The PMV stands for the percentage of people who will be satisfied with the conditions. It was used as norm the ASHRAE 55, which also considers the elevated air speed on the calculation of the PMV. The results show the significance of natural ventilation and solar protection. As it can be expected, the worst case was the one with the glass window and limited natural ventilation, in this case 50% of the occupied hours the conditions are too hot to be comfortable. The best case was the one with wooden louvers with 80% of the time with comfortable conditions. These results show how important is the natural ventilation on these apartments, and how efficient is the original louver window. Despite this, wooden windows are no longer an option for most of Cubans, the price is too high, and usually people depend on the black market in which metal and glass are available.

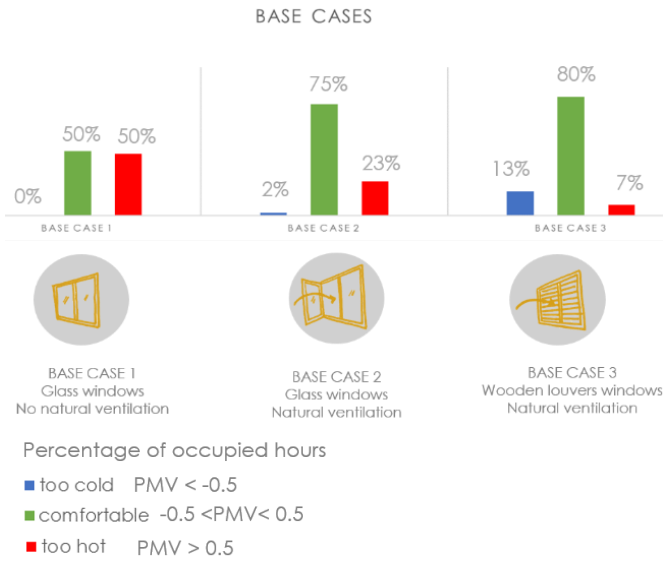


Figure 7: The base-cases results

With the previous analysis, it can be concluded that now the users must choose between having thermal comfort by letting air in but be annoyed by the noise and the people looking inside, or be quiet and private but warm. Also, the economic situation only allows for the use of certain type of windows that are not flexible enough. My proposal must solve this conflict.

Strategies identification

To solve the conflict with natural ventilation and comfort related before, it was decided to find a solution by fostering cross ventilation. The idea was to use the space of the stairs as a chimney to drive the air out of the apartments. Stairs would be taken out; therefore, the new windows will be in a more private position, offering better chances for the people to open them. The efficacity of this measure will be less in the higher floor, that is why it is proposed that in combination with the new atrium, shading must be added in the roof. This last measure would be beneficial to reduce the solar gains substantially in the top floor.

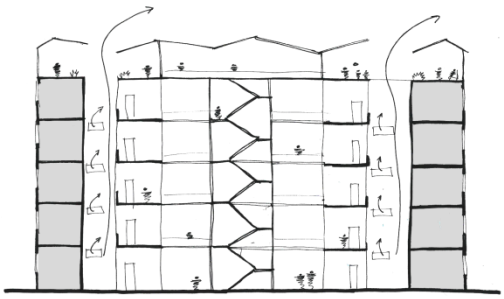


Figure 8: Strategy 1. Stairs out for atrium +Roof shading

Apart from the benefits on comfort that this solution can give, it is necessarily to think on the feasibility of a proposal like this. This kind of intervention can only be done with the investment of big amount of money. It is probable that the government will not provide the funds for such an intervention. Therefore, it was necessary to create another strategy which can be assumed by the inhabitants of the apartments. The idea was to design a DIY (Do It Yourself) system capable to offer options for visual and sound privacy, solar protection but giving at the same time ventilation. The main characteristic of the system should be flexibility, allowing the users to freely choose the desire combination at any time.

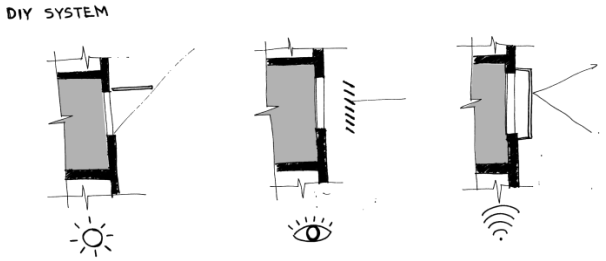


Figure 9: Strategy 2. DIY system

The most challenging theme to solve in the system was the acoustic protection. From the beginning it was evident that the only effective way to protect spaces from noises of different frequencies and directions was to have a box in front of the windows, with two openings located in opposite positions. This situation would prevent that the acoustic device can be mounted and dismounted at any time.

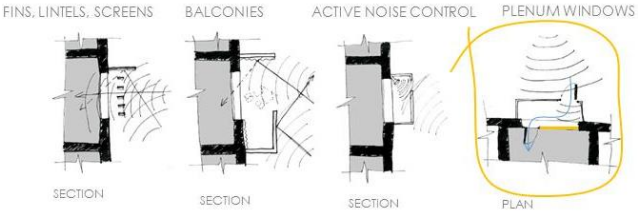


Figure 10: Different options for noise protection

The final proposal would be of two DIY systems, the first one can be flexible giving protection for privacy and sun with natural ventilation. The second device will be the noise control box with additional features of natural ventilation and solar protection.

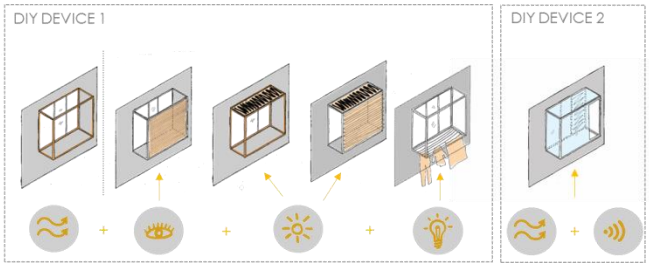


Figure 11: DIY devices

Evaluation

The next step was to evaluate the strategies according to the achievement of comfort.

It was tested an apartment in an intermediate floor without atrium and with atrium. The results showed that this solution increments the hours in comfort.

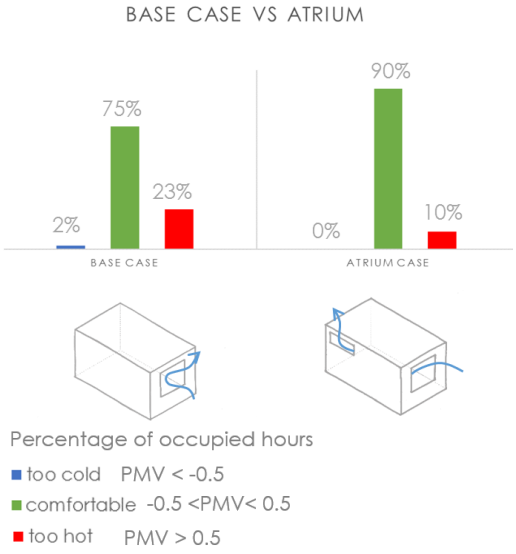
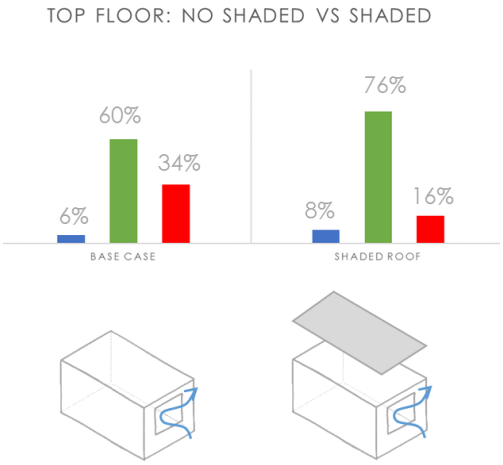
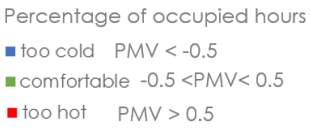


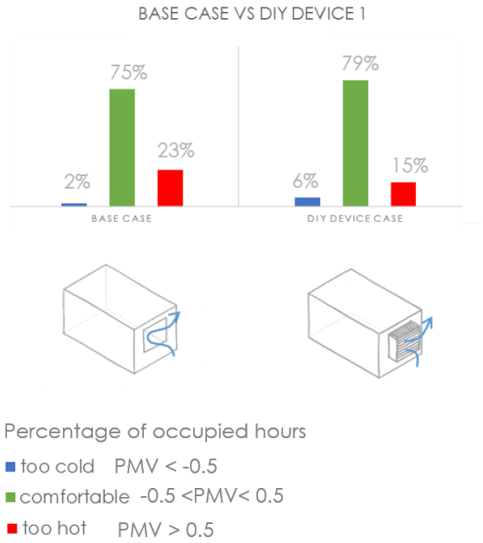
Figure 12: Evaluation of the atrium

The efficacy of the roof shading was also tested using TRNSYS and the results showed an increase of 16% of comfortable hours.

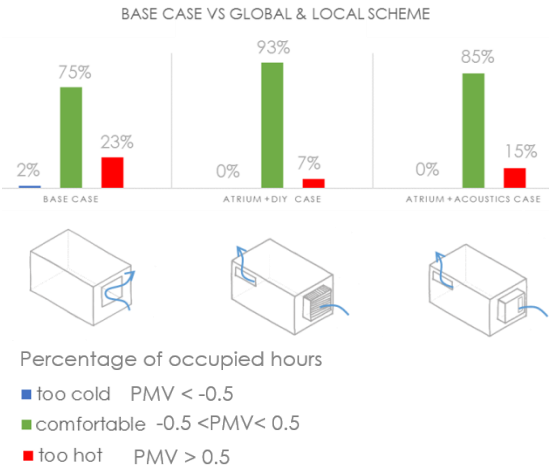




The DIY device 1 was also tested. The improvement is not as high as in the other cases, but is still better than in the original state.



The combinations of both strategies, the atrium solution and the two DIY devices were also tested. And the results confirmed the efficacy of all strategies.



Proposal

The evaluation of the strategies showed that they can be effective to improve the living conditions of the inhabitants in the “microbrigada” buildings in Cuba. The first strategy of the atrium and the roof shading allows the use of two of the principal passive strategies to achieve comfort in hot-humid climates: cross ventilation and shading. One of the advantages of this scheme is that the urban space in front of the buildings can be redesigned and activated by the presence of the stairs. Also, a new protected space in the top of the buildings would be created, giving additional room for new activities.

The second strategy, the DIY devices, has the advantage that it can be applied to all buildings regardless orientation or location. The main characteristic of this scheme is the flexibility.

For all these, the final proposal includes both of the strategies.

Conclusion

This project showed that is possible to improve the comfort of thousands of families in Cuba by retrofitting the “microbrigada” buildings. The final proposal was evaluated according to the achievement of confortable conditions; however, no strategy would be effective if the social conditions were not considered. Cuba`s special circumstances were instrumental to decide the type of solution to tackle the problems.

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