Housing Daylight in Urban Centres. Study Case: Havana

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ABSTRACT: The integral rehabilitation of central urban areas is a main condition for sustainability, allowing the preservation of the heritage and taking advantage of the urban land as well as the existing facilities and infrastructure in the city centre. Urban microclimate has been recently studied and some contradiction in the appropriate architectural designs to solve different climatic variables, arise from these researches. The present paper offers the results of the indoor daylight simulation in some architectural models proposed to be inserted in the traditional centre of Havana. From these results, some recommendations and indexes for architectural and urban design are proposed in order to guarantee appropriate indoor daylight in the new multifamily buildings to be built in those central urban areas in Havana.

Keywords: housing daylight simulation

1. INTRODUCTION

The integral rehabilitation of central urban areas is a main condition for sustainability, allowing the preservation of the heritage and taking advantage of the urban land as well as the existing facilities and infrastructure in the city centre.

Urban microclimate has been recently studied and some contradictions in the appropriate architectural designs to solve different climatic variables arise from these researches. However, daylight seems to be the more precise variable to set the limits between the land occupation index and the indoor environment.

The present paper offers the results of the indoor daylight simulation in some architectural models proposed to be inserted in the traditional centre of Havana.

2. CENTRAL URBAN AREAS

Figure 1: View of Havana Centre.

Traditional central urban areas are usually preferred by people, because of their environment; level of services, facilities and animation; centrality, communication and transportation, and also, because of their historical and cultural accumulated values. Those are important reasons for their preservation.

These urban zones are generally high density and compact in land occupancy (index higher than 0.8), with continues façade lines, common walls without spaces between buildings in long and narrow plots, organized in blocks according to a grid derived from the original Mediterranean urban model brought to America by the Spanish colonizers.

Then, needed relationship between indoors and outdoors in buildings (for daylight, ventilation and sights), are produced to the street (limited by the narrow plot) and to an internal yard, which has suffered an evolution from the original court yard to the more common and traditional lateral yard, arriving to the small yards called “patinejos” or “wind boxes” in the multifamily buildings constructed in the 50’s as a result of the land speculation.

3. URBAN MICROCLIMATE

In spite than the architectural model proposed in almost all bioclimatic manuals for warm and humid climates suggests an open urban solution, studies carried out 20 years ago in Havana showed that these compact urban areas could be better than the modern open ones according to thermal environment [1].

The explanation of this phenomena suggested a different microclimatic behaviour of the compact urban areas based on the thermal inertia, according to what, ventilation could be no so important as in open urban models it was. However, there have been different approaches among authors who could give more or less importance to the natural ventilation as a thermal regulator even in that urban context [2].

Based on the values of the traditional urban tissue and the advantages of its microclimate stated by the precedent researches, the Physical Planning Office in Havana is proposing to keep the existing land occupancy coefficient in the integral rehabilitation program for the central urban areas.

The thermal indoor environment is difficult to evaluate and to determine the exact influence of the urban morphology on it, specially, the land occupancy index, because of the great amount of factors which take place, the variability of each of them and the infinite possible combination of situations: wind, its variations and modifications by urbanism and architecture; temperature; humidity; building materials, surface albedo, reflectivity, absortivity, emissivity, conductivity, time lag; architectural shape, and so on.

However, indoor daylight is more related to the geometry of the building and the context, and of course, the sky luminance and the reflection coefficient in surfaces (internal and external), and then, it is easier to simulate and to get trustable results. That's why daylight has been taken as the limit condition between the indoor environment and the land use coefficient.

4. HAVANA CENTRE AS A STUDY CASE

Figure 2: Plan of Havana Centre.

The municipality Havana Centre was the first extension of the historical city out of the walls in the XIX Century and constitutes its traditional commercial core.

With an extension of 375 Ha and 140900 inhabitants, it is structured in an irregular grid of streets oriented North – South and East – West. Its morphology, similar to the rest of the central compact urban zones is composed by buildings 2.5 average stories and the Land Occupancy Coefficient is 0.80.

As in other central urban areas, the Physical Planning Office of Havana City is proposing an integral and participative rehabilitation process organised by blocks that starts with the construction of new multifamily buildings in the existing empty plots. However the new buildings can't reproduce the former solutions, not only because the life stile has changed and the current social housing impose different approaches and standards, but also because it has been proved than the existing architectural and urban solutions don't satisfy daylight requirements indoors [3].

In order to propose new architectural schemes, the available plots were studied and classified according to their dimensions, proportions, height of surrounding buildings, and the needed modulation of indoor spaces. Not only empty plots were considered, but also those occupied by unrecoverable buildings.

5. NEW ARCHITECURAL SCHEMES

New architectural schemes were based on the following design principles: continuity of the façade line as an important context feature; volumes depth no more than two modules (7.20 m) to allow minimum daylight levels required in the points more distant to the windows; all interior spaces directly related to outdoors (ones to the streets and others to internal yards which dimensions and proportions guarantee daylight and privacy indoors).

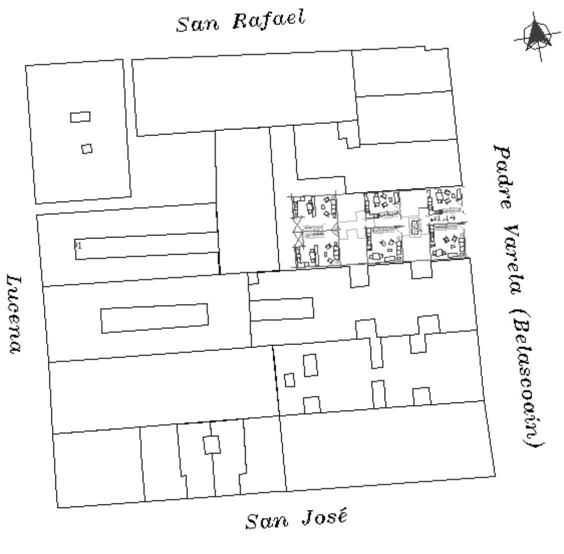

Figure 3: Schematic plan for new architectural proposals.

6. DAYLIGHT SIMULATION

Simulation process was developed using ADELINE (Advanced Daylighting & Electric Lighting Integrated New Environment) and its modules SUPERLITE and RADIANCE, using the Daylight

Factor to evaluate the satisfaction of the standard for housing. It allows avoiding the possible differences between the design sky model (uniform) and the real sky (partially cloudy).

A model of a real existing building was simulated and compared to measurements of daylight level indoors and outdoors carried out in the same building. The coincidence of the results obtained by measurements and simulation confirmed the validity of the software.

Virtual models were built according to the more frequent street section (9.00 m), buildings height (between 5.40 m and 10.80 m) and plot types (width 5.00 m, 7.20 m and 11.00 m). In order to facilitate the simulation process it was considered unilateral illumination, adding the result when in open spaces bilateral illumination is possible. Reflection coefficients were assumed as suggested in regulations and the windows area were accurately calculated as the equivalent value with a transmission coefficient, to take as much advantage as possible from the reflection of daylight in upper surfaces where less windows areas are needed, and vice verse.

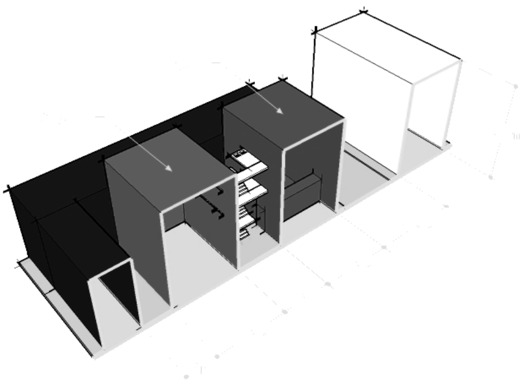

Figure 4: Bases for simulated virtual models

7. RESULTS

According to the results obtained in the simulation process, required daylight levels can be satisfied at the points more distant to the windows in spaces related to the streets, even in the ground floor, providing the appropriate windows (surface, type and colour). In spaces related to the internal and the back yards, the satisfaction of daylight levels depend on the plot with and the yard depth, according to the building height.

For four story buildings (equivalent to the traditional two story buildings existing in the context), the internal yard depth required for daylight varies from 8.00 m to 11.00 m, while the back yard depth could be between 4.00 m and 7.00 m, depending to the plot width (11.00 m to 5.00 m). The minimum open space required for two-story building (equivalent to one story building existing in the context) varies from 3.50 m to 4.50 m and the back yard from 1.75 m and 2.00 m, also according to the plot width.

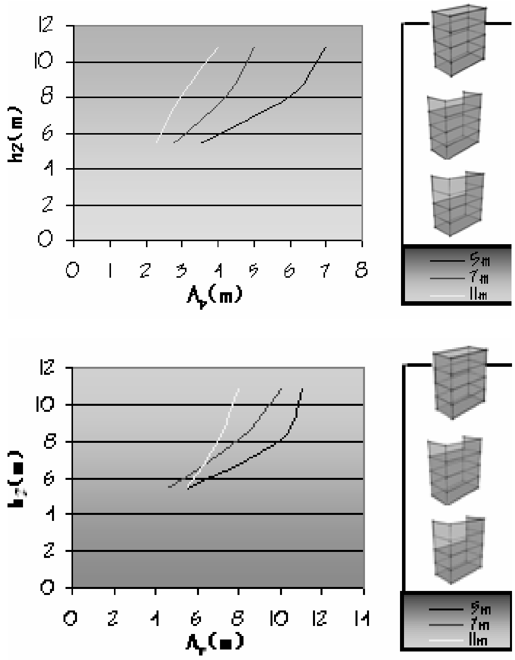

Figure 5: Depth of the central and back yard according to the yard width and the buildings height

Land occupancy coefficient required to guarantee daylight indoors in this compact urban context based on the architectural schemes proposed and taking into account the results of the simulation process, are between 0.44 and 0.66. This fact reinforce the necessity to reconsider the present regulation proposed by the Physical Planning Office in Havana about keeping the existing land occupancy coefficient (0.80) in that compact central urban areas.

5. CONCLUSION

Present generations have a lot to learn from the traditional urban centres, respect to their environment, but these centres, when them still exists (as in Havana case), should be changed, mainly towards indoors, in order to fit better to new living stiles, standards and requirements.

It could be good to preserve the urban environment, taking advantage of the urban land, services, infrastructure and centrality, but improving the indoor living environment. Daylight is an important limit and equilibrium point for that.

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